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TO
SIR CHARLES FREDERICK,
KNIGHT OF THE MOST NOBLE
ORDER OF THE BATH,
SURVEYOR GENERAL OF HIS
MAJESTY'S ORDNANCE,
AND FELLOW OF THE ROYAL
SOCIETY, AT LONDON,

THIS TREATISE
ON ARTIFICIAL FIREWORKS
IS HUMBLY INSCRIBED

BY

HIS MOST OBEDIENT
AND MUCH OBLIGED

HUMBLE SERVANT,

ROBERT JONES.

TO

THE

KNIGHT OF THE

ORDER OF

SUPREMACY

OF THE

KNIGHTS

OF THE

KNIGHTS

OF THE

KNIGHTS

OF THE

KNIGHTS

OF THE

KNIGHTS

OF THE

KNIGHTS

Rich^d Booth
May: 1775

P R E F A C E.

I SHALL not pretend to say any thing here concerning the origin of Fireworks; those who are willing to be better informed of that point, may have recourse to the treatise of M. F***, on that subject, who has handled this point in a most elaborate manner; and perhaps it may be no displeasing surprize to the reader, to find that, while he imagines himself only concerned about an invention which he could not have thought to have subsisted above 422 years, he is carried gradually back to the age of Augustus, and from thence to the time of the Trojan war.

It is sufficient for me that Fireworks have subsisted a long time, and still continue to do so among the politest nations of both Europe

and Asia. I am very well aware that it may here be objected, there are already treatises published on this subject, and some of those voluminous ones; but then those are either translations from the French and Italian authors, &c. which in themselves are both imperfect and erroneous; or else they are very small abridgments, and those little, not of the art itself, only on some particular branches of it.

I have endeavoured, in the following treatise, to avoid prolixity as much as possible without being obscure; the rules I have laid down, are as plain as was in my power to make them, and I have endeavoured to carry the reader in by the most gradual manner, from the minutest circumstances to the highest, and have been careful to keep

P R E F A C E. vii

keep to the subject I first proposed, only as an Essay on Artificial Fireworks. I own I cannot help reflecting with some kind of chagrin, that, whenever we have had occasion for any of these sort of diversions to be exhibited in England, we have almost always had recourse to foreigners to execute them; if this has been owing to the ignorance of our own people on this subject, I shall be very happy if it is in my power to correct it; if it is only owing to that prevailing fondness we entertain for every thing that is foreign, I know no remedy for that evil but time and experience.

June 20, 1765.

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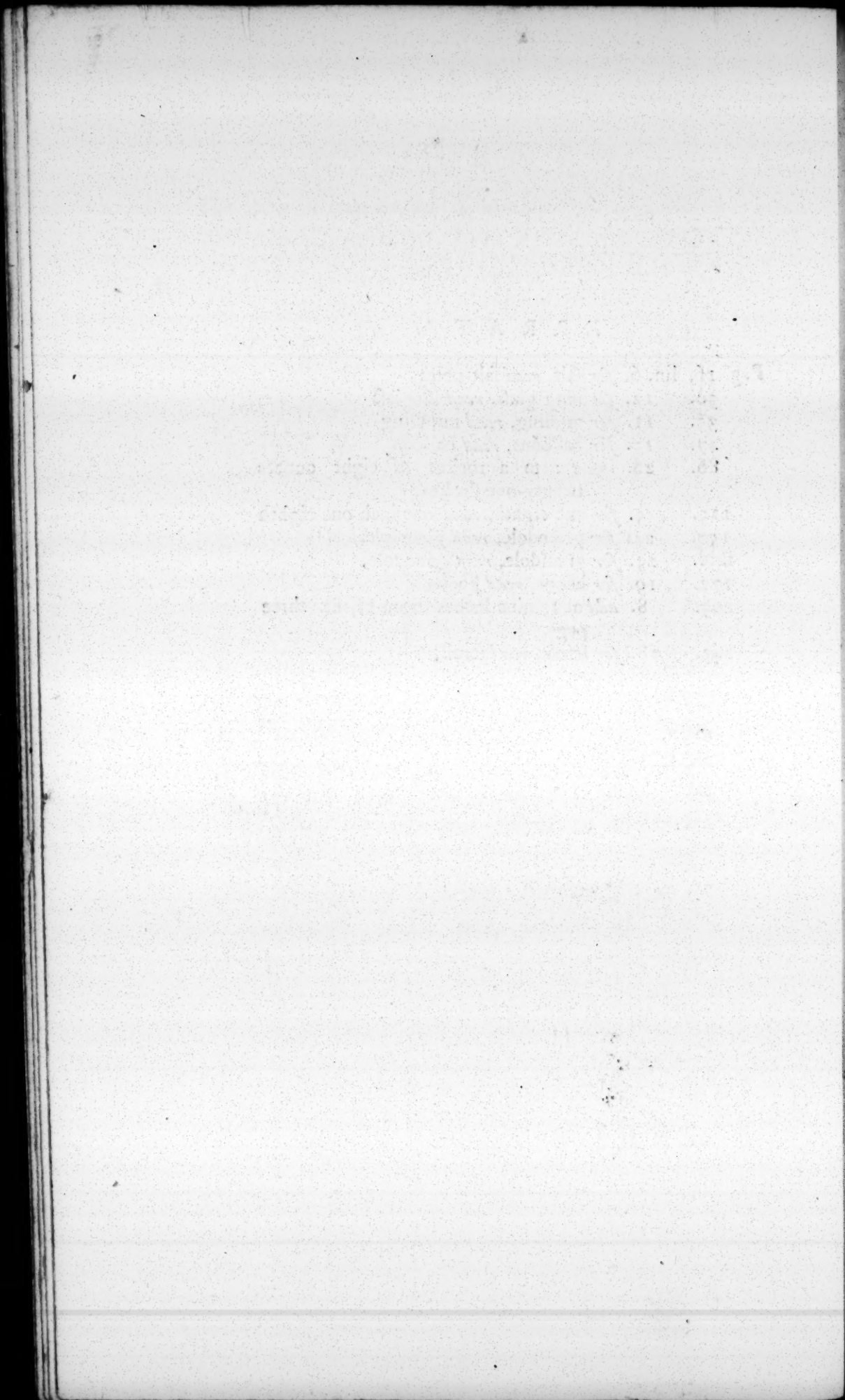
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E R R A T A.

- Pag. 16. lin. 6. *for salt, read salt-petre*
 30. 12. *for ifing glafs, read ifinglafs*
 35. 11. *for midling, read middling*
 47. 15. *for ballóons, read ballóon*
 86. 26. *insert : to a rocket of eight ounces*
 twenty-one ftrokes.
 115. 5. *for one eighth, read one inch one eighth*
 152. 24. *for griandole, read girandole,*
ibid. 25. *for griandole, read girandole,*
 172. 19. *for hoops, read hooks,*
 203. 8. *add at I, nine inches from H, fix three*
 pegs.
 243. 18. *for fcrole, read fcroll,*



A
T R E A T I S E
O N
Artificial Fireworks.

S E C T. I.

Of SALTPETRE.

SALTPETRE being the principal ingredient in fireworks, and a volatile body, by reason of its aqueous and aërial parts, is easily rarified by fire; but not so soon when foul and gross, as when purified from its crude and earthy parts, which greatly retard its velocity: therefore, when any quantity of Fireworks are intended to be made, it would be necessary first to ex-

B

amine

amine the saltpetre; for if it be not well cleansed from all impurities, and of a good sort, your works will not have their proper effect, neither will it agree with the standing proportions of compositions: but to prevent accidents I shall proceed with the method of refining it.

How to refine SALTPETRE.

Put into a copper, or any other vessel, one hundred weight of rough nitre with about fourteen gallons of clean water, and let it boil gently for half an hour, and as it boils take off the scum; then stir it about in the copper, and before it settles put it into your filtering bags, which must be hung on a rack, with glazed earthen pans under them in which must be sticks laid across for the crystals to adhere to; it must stand in the pans for two or three days to shoot, then take out the crystals and let them dry: the water that remains in the pans boil again for an hour, and strain it into the pans as before, and the saltpetre will be quite clear and transparent; if not, it wants more refining, to do which proceed as usual, till it is well cleansed of all it's earthy parts.

N. B.

ARTIFICIAL FIREWORKS. 3

N. B. Those who do not chuse to procure their saltpetre by the above method, may buy it ready done, which for fireworks in general will do equally as well.

How to pulverise SALTPETRE.

Take a copper kettle whose bottom must be spherical, and put into it fourteen pound of refined saltpetre, with two quarts or five pints of clean water ; then put the kettle on a slow fire, and when the saltpetre is dissolved, if any impurities arise, skim them off, and keep constantly stirring it with two large spatulas, till all the water exhales ; and when done enough, it will appear like white sand, and as fine as flour ; but if it should boil too fast, take the kettle off the fire, and set it on some wet sand, which will prevent the nitre from sticking to the kettle. When you have pulverised a quantity of saltpetre, be careful to keep it in a dry place.

How to extract SALTPETRE from damaged GUN-POWDER.

First you must have some filtering bags, hung on a rack, with glazed earthen pans

B 2

under

under them, in the same manner as those for refining saltpetre: then take any quantity of damaged powder, and put it into a copper, with as much clean water as will just cover it; and when it begins to boil take off the scum, and after it has boiled a few minutes, stir it up; then take it out of the copper with a small hand kettle for that purpose, and put some into each bag, beginning at one end of the rack, so that by the time you have got to the last bag, the first will be ready for more; continue thus, till all the bags are full; then take the liquor out of the pans, which boil and filter, as before, two or three times, till the water runs quite clear, which you must let stand in the pans for some time, and the saltpetre will appear at top. Now to get all the saltpetre entirely out of the powder, take the water from the saltpetre already extracted, to which add some fresh water and the dregs of the powder that remain in the bags, and put them together in a vessel, to stand as long as you please, and when you want to extract the nitre, you must proceed with this mixture as with the powder at first, by which means you will draw out all
the

ARTIFICIAL FIREWORKS. 5

the saltpetre ; but this process must be boiled longer than the first.

Of SULPHUR, or BRIMSTONE.

Sulphur is by nature the food of fire, and one of the principal ingredients in gunpowder, and almost in all compositions of fireworks ; therefore great care ought to be taken, of its being good and brought to the highest perfection. Now to know when the sulphur is good, you are to observe that it be of a high yellow, and if, when held in one's hand, it crackles and bounces, it is a sign that it is fresh and good : but as the method of reducing brimstone to a powder, is very troublesome to do, it is better to buy the flower ready made, which is done in large quantities, and in great perfection : but when a grand collection of fireworks are to be made, the strongest and best sulphur to use, is the lump brimstone ground in the same manner as gun powder, which we shall treat of in the following part of the treatise.

How to prepare CHARCOAL for Fireworks.

Charcoal being a preservative by which the saltpetre and the brimstone is made into gun-powder, by preventing the sulphur from suffocating the strong and windy exhalation of the nitre. There are several sorts of wood made use of for this purpose; some prefer hazle, others willow and alder; but there being so little difference, you may make use of either which is most convenient to be got. And the method of burning the wood is this: Cut it in pieces about one or two feet long, then split each piece in four parts; scale off the bark and hard knots, and dry them in the sun or in an oven, then make in the earth a square hole, and line it with bricks, in which lay the wood, crossing one another, and set it on fire; when thoroughly lighted and in a flame, cover the hole with boards, and fling earth over them close, to prevent the air from getting in, yet so as not to fall among the charcoal, and when it has lain thus for twenty-four hours, take out the coals and lay them in a dry place for use. It is to be observed that
charcoal

charcoal for fireworks must always be soft and well burnt, which may be bought ready done.

To make Artificial CAMPHOR.

Camphor, in the *Materia medica*,
 “ is a body of a particular nature, being
 “ neither a resin, nor a volatile salt, nor
 “ an oil, nor a juice, nor a bitumen,
 “ nor a gum, but a mixed substance,
 “ dry, white, transparent and brittle,
 “ of a strong and penetrating smell.
 “ The Indians distinguish two kinds of
 “ it, a finer and a coarser; the finer is
 “ the produce of Borneo and Sumatra,
 “ is very rare, and is hardly ever sent
 “ into Europe; the coarser is the Japo-
 “ nese kind, which is the common sort,
 “ both in the Indies and in Europe.

“ The camphor, which we meet
 “ with in the shops, is also of two
 “ kinds, differing in regard to the degree
 “ of their purity, and distinguished by
 “ the name of rough and refined cam-
 “ phor. The tree, which produces
 “ camphor, is a species of bay tree,
 “ every part of which abounds with
 “ camphor; but is not collected from

“ it in the manner of resins, but by a
“ sort of chemical process. — The na-
“ tives of the place where the trees
“ grow, cut the wood and roots into small
“ pieces. And put them into large cop-
“ per vessels, which they cover with
“ earthen heads, filled with straw; they
“ give a moderate fire under them, and
“ the camphor is raised in form of a
“ white downy matter, and retained
“ among the straw; when the process
“ is over, they shake it out of the straw,
“ and knead it into cakes. These cakes
“ are not very compact, but easily crum-
“ bled to pieces; they are moderately
“ heavy, of a greyish or dusky reddish
“ white in colour, of a pungent smell
“ and acrid taste, and are what we call
“ rough camphor.

“ Refined camphor must be chosen of
“ a perfectly clean white colour, very
“ bright and pellucid, of the same smell
“ and taste with the rough, but more
“ acrid and pungent. — It is so vola-
“ tile that merchants usually inclose
“ it in lin-seed, that the viscosity of
“ that grain may keep its particles to-
“ gether.”

Now

ARTIFICIAL FIREWORKS. 9

Now there is also an artificial camphor for fireworks, which I shall here give you the method of making; take of gum sandarach pulverised two pound, and of distilled vinegar enough to cover it; put them together in a glass phial, and set it for twenty days in warm horse dung. Then take it out again, and pour it into another phial, with a large mouth to it; and expose it to the sun for a month, and you will have a concreted camphor in form of the crust of bread, and something like the natural camphor: which when you use must be ground to a powder with a little spirits of wine in a mortar. Though we have here taught the method of making artificial camphor, I would not recommend it to those who chuse to make their works to perfection, the natural camphor, being by far the best.

To make the OIL of CAMPHOR.

The oil of camphor, which is sometime used to moisten compositions, is produced by adding to some camphor a little oil of sweet almonds, and working them together in a brass mortar, till it turns to a green oil.

N. B.

N. B. Those works that have any camphor in their compositions, should be kept as much from air as possible, or the camphor will evaporate.

Of BENJAMIN.

Benjamin is a resin (much used by perfumers, and sometimes in medicine); it is brought from the Indies, where it is found of different sorts; and distinguished by the following colours, viz. yellow, grey, and brown, but the best is that which is easy to break and full of white spots.

Benjamin is also one of the ingredients in odoriferous fireworks, when reduced to a fine flour; which may be done by observing the following directions. Put into a deep, and narrow earthen pot, three or four ounces of benjamin grossly pounded, cover the pot with paper, which tie very close round the edge; then set the pot on a slow fire, and once in an hour take off the paper, and you will find some flower sticking to it, which return again in the pot; this you must continue till the flower appears

pears white and fine. There is also an oil of benjamin, which is sometimes drawn from the dregs of the flour; it affords a very good scent, and may be used in wet compositions.

Of GUN-POWDER and its original.

Gun-powder being a principal ingredient in fireworks, it will not be improper to give a short definition of its strange explosive force, and cause of action, which, according to Dr. Shaw's opinion, of the chemical cause of the explosive force of gun-powder, is as follows.

“ Each grain of powder consisting of
 “ a certain proportion of sulphur, nitre,
 “ and coal, the coal presently takes fire,
 “ upon contact of the smallest spark: at
 “ which time both the sulphur and the
 “ nitre immediately melt, and by means
 “ of the coal interposed between them,
 “ burst into flame; which spreading
 “ from grain to grain, propagates the
 “ same effect almost instantaneously:
 “ whence the whole mass of powder
 “ comes to be fired; and as nitre con-
 “ tains both a large proportion of air and
 “ water, which are now violently rari-
 “ fied

“fied by the heat, a kind of fiery explosive blast is thus produced, wherein the nitre seems, by its aqueous and aërial parts, to act as bellows to the other inflammable bodies, sulphur and coal, to blow them into a flame, and carry off their whole substance in smoke and vapour.”

After having spoke of the nature of powder, I shall in the next place proceed to its original, though somewhat uncertain; but it is imagined to have been invented in the time of Alexander the great, as Philostratus speaks of a city near the river Hypafis in the Indies, that was said to be impregnable and its inhabitants relations of the gods, because they threw thunder and lightning on their enemies; but this perhaps might be the effect of gun-powder, which, not being known by any other people, might very well be said to be thunder and lightning.

This conjecture has been confirmed by some travellers, who assert that it was used in the East Indies, particularly in the Philippine Islands about the year 85, which is 1265 years before it was known in Europe, where they say
it

it was not known till 1350, though, it is said, there is mention made of gunpowder in the registers of the chambers of accounts in France, as early as the year 1338, and Friar Bacon mentions the composition of powder in express terms, in his treatise *De nullitate magiae*, published at Oxford in the year 1216; but we find from most accounts, that the Germans have the honour of the invention, as is commonly reported.

I should give a description of a machine for the trying of gun powder, but they being so common, it would be needless; yet, would have all those who practice this art, know, that, when they make fky rockets with powder, that it must be of the best sort; but as to wheels, and other common works, any powder will do, only be careful that it is quite dry.

Of the Compositions for GUN- POWDER of different sorts.

Having treated of the nature of powder, and its original, I shall here give the proportion of each ingredient, necessary for composing the different sorts
of

of gun-powder, it being proper that every one who makes use of powder, should know of what it is composed. Therefore in the first place; I shall set down the several compositions mentioned in Casimir Siemienowicz's grand art of artillery, in which there are six sorts, viz.

- I. Saltpetre one hundred pound, sulphur twenty five pound, and coal twenty five pound.
- II. Saltpetre one hundred pound, sulphur eighteen pound, and coal twenty pound.
- III. Saltpetre one hundred pound, sulphur twelve pound, and coal fifteen pound.
- IV. Saltpetre one hundred pound, sulphur twenty pound, and coal twenty four pound.
- V. Saltpetre one hundred pound, sulphur fifteen pound, and coal eighteen pound.
- VI. Saltpetre one hundred pound, sulphur ten pound, and coal eight pound.

Mr.

Mr. Belidor, in his *Hydraulics*, speaks of a composition for gun powder which is as follows, to thirty pound of saltpetre, add five pound of sulphur, with as much coal: but the proportion of the several ingredients for powder, are to be found best by experience. For tho' there has been so much practice in making powder, there has not yet been ascertained a standing proportion of the nitre, sulphur, and coal; but it is hoped that in time this great and noble invention will be much improved, and that the different, and best quantity of every ingredient, will be determined. At the powder mills they generally allow for wasting, in making up, one pound and a half in a hundred. And their mixture for a hundred weight of good powder is thus: To seventy-six pound and a half of saltpetre, well refined and dry'd, twelve pound and a half of coal, and as much sulphur, all which added together makes one hundred one pound and a half, which when worked up will nearly weigh one hundred. As it is most certain that gun-powder is capable of being improved, I shall not omit any particular that may be of service to such ingenious

ingenious gentlemen as are willing to make experiments ; for which reason we shall here insert another composition for powder, mentioned by an author on this subject, whose name I have forgot, but the composition is thus: Refined salt~~petre~~^{petre} five pounds, sulphur one pound four ounces, and charcoal seven ounces and a half.

But notwithstanding you may have a good proportion of ingredients, the powder will not always be the same, for there is a great deal depends on their being well incorporated, corned and dry'd, the method of which will be taught in the next article.

To restore damaged GUN-POWDER to its proper strength.

It is most certain, that, if powder be kept long in a damp place, it will become weak and moist, and great part of it will be formed into hard lumps, which is a certain sign of its being damaged. When powder is thus found, you will also see at the bottom of the barrel some saltpetre, which, by being wet, will separate from the sulphur and coal, and al-
always

ways fall to the bottom of the vessel wherein the powder is contained, and settle there in the form of a white downey matter; but the only method to prevent this, is to move the barrels as often as convenient, and place them on their opposite sides or ends, to which they before stood: but although ever so great care be taken of powder, and it be kept as dry as possible, length of time will greatly lessen its primitive strength.

Therefore when any of the above mentioned accidents happen to your powder, you may recover it by applying to the directions here given; for example, if you imagine that the powder has not received much damage, proceed thus. Spread it on canvas, or dry boards, and expose it to the sun, then add to it an equal quantity of good powder, and mix them well together, and, when thoroughly dry, barrel it up, and put it in a dry and proper place. But if gun-powder be quite bad, the method to restore it is as follows; first, you must know what it weighed when good; then, by weighing it again, you will find how much it has lost by the separation and evaporation of the saltpetre; then add

C

to

to it as much refined saltpetre, as it has lost in weight, but as a large quantity of this would be difficult to mix, it will be best to put a proportion of nitre, to every twenty pound of powder; when done, put one of these proportions into your mealing table, and grind it therein, till you have brought it to an impalpable powder, and then searce it with a fine sieve; but if any remain in the sieve that will not pass through, return it to the table, and grind it again, till you have made it all fine enough to go through the sieve; being thus well ground and sifted, it must be made into grains in the following manner, first you must have some (copper wire sieves) made according to what size you intend the grains should be; these are called corning sieves or grainers, which being provided, fill them with the powder composition, then shake them about, and the powder will pass through the sieve formed into grains. Having thus corned your powder, set it to dry in the sun; and when quite dry, searce it with a fine hair sieve in order to separate the dust from the grains. This dust may be worked up again with another mixture; so that none of the powder

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powder will be wasted : but sometimes it may so happen, that the weight of the powder when good cannot be known; in which case add to each pound an ounce or an ounce and a half of saltpetre, according as the powder is decayed, and then grind, sift, and granulate it as before directed.

N. B. If you have a large quantity of powder, that is very bad, and quite spoiled; the only way is to extract the saltpetre from it, according to the usual manner: for powder thus circumstanced, would be very difficult to recover.

Of SILENT POWDER, commonly called WHITE POWDER.

It would be rather absurd for any one to imagine, that it is possible for gunpowder to have any effect without some report, when it is plain and well known, that the sound does not proceed from the powder only, but from the air being rarified by the expansion of the powder.

From whence it is evident, that any composition acting with the same explosive force as gun-powder, would cer-

tainly produce the same effect, in every respect. However as for such sort of powder I never had any proof, nor ever knew any experiment made of it, but have so little opinion of it, that I should not have given it a place in this work, had it not been treated of by some authors of note; and at the same time giving every one, who is fond of this art, an opportunity of making experiments, and of knowing every thing belong thereto.

To make SILENT POWDER.

For the first sort, mix two pound of borax, with four pound of gun-powder.

2d. Add half a pound of lapis-calaminaris, and half a pound of borax, to two pound of powder.

3d. To six pound of gun-powder, half a pound of calcined moles, with as much borax of Venice.

4th. To six pound and a half of salt-petre, eight pound and a half of sulphur, and half a pound of the second bark of an elder tree, burnt and ground to a powder, with two pound of common salt.

There

There are also many other methods of making powder silent, according to report, by using camphor or touchwood instead of charcoal, or by adding to the common powder burnt paper, hay seed, &c. When any of these ingredients are to be mixed with common powder, grind them together, and make them into grains.

To make GUN-POWDER of different Colours.

Notwithstanding the repeated trials and experiments made by the greatest artists, to add to the strength of gun-powder, all have proved without success, and most of them have agreed that the present powder will not admit of a fourth ingredient; therefore it is evident, that any thing being mixed with the present composition of gun-powder, would rather reduce it's strength than add to it; consequently coloured powder must be weaker than black; so that the making of powder of different colours, is only a fancy that serves to please the curious, without any other effect.

To make GUN-POWDER white.

To six pound of salt-petre, add one pound of the pith of an elder tree, well dried and pulverised, with a sufficient quantity of brimstone to make it into powder, which you will find in the composition of gun-powder, or an ounce of the salt of tartar, calcined till it comes white, and then boiled in clear water, till the water is all evaporated.

To make POWDER red.

Boil in water some brasil wood or vermillion and a pound of chopped paper; and, when boiled for some time to draw out the colour, dry and meal it with a pound of sulphur, and eight pound of saltpetre.

Or, to six pound of saltpetre, put one pound of sulphur, and half a pound of amber, and blood stone one pound.

To

To make Yellow POWDER.

Take eight pound of saltpetre, and one pound of sulphur, to which add one pound of wild saffron, that has been boiled in aqua vitæ, and afterwards made dry and mealed.

To make Green POWDER.

Boil two pound of rotten wood, with some verdegrease in aqua vitæ, then dry and pound it, and mix it with a pound of sulphur, and ten pound of salt-petre.

To make Blue POWDER.

Boil some indigo in aqua vitæ, with a pound of the bark of a young linden tree, then dry and reduce it to a powder, and mix it with a pound of brimstone, and eight pound of saltpetre.

To make Pulvis Fulmanans, or
Thunder in a Room.

This composition is very simple, yet has a very curious effect; it is made of three parts of saltpetre, two of salt of tartar, and one of sulphur, all ground to a fine powder, and well incorporated together. As the effect of this powder is quite different to that of gun-powder, so is there a different method of firing it, which is thus: Put about two tea spoonfulls of it into a fire-shovel, or iron ladle, and set it over a slow fire, and when it is quite hot, it will go off with a violent report. There is something surprising in the nature of this composition; for as the common powder acts every way equal, and makes the greatest noise when confined, this, on the contrary, acts only downwards, and makes the strongest report when not confined.

There is another sort of fulminating powder, called fulmanans aurum, on account of there being gold mixed in its composition, which is done by a chemical

ARTIFICIAL FIREWORKS. 25

cal preparation; but as the preparing of the ingredients require a tedious and expensive process, I shall omit the method of doing it, and let those who chuse to make chemical experiments refer to authors on that subject, by whom they will find the manner of making this powder fully explained. It is said one grain of fulmanans aurum, when made to perfection, and held on the point of a knife, over a candle, will make a report louder than a musket.

S E C T.

S E C T. II.

Of the SPUR-FIRE.

THIS fire is the most beautiful and curious of any yet known, and was invented by the Chinese, but now is in greater perfection in England, than in China; and as it requires a great deal of trouble to make it to perfection, it will be necessary that young beginners should have full instructions in every particular; therefore care ought to be taken that all the ingredients be of the best sort, that the lamp-black is not damp and clodded, and that the saltpetre and brimstone are thoroughly refined. This composition is generally rammed in one or two ounce cases, about five or six inches long, but not drove very hard; and these cases must have their concave stroke struck very smooth, and the choak or vent not quite so large as the usual proportion; this charge, when driven
and

and kept a few months, will be much better than when just rammed, but will not spoil, if kept dry, in many years.

Now as the beauty of this composition cannot be seen at so great a distance as brilliant fire, it has a better effect in a room than in the open air, and may be fired in a chamber without any danger; for it is of so innocent a nature, that, though with an improper phrase, it may be called a cold fire; and so extraordinary is the fire produced from this composition, that, if well made, the sparks will not burn a handkerchief, when held in the midst of them; you may hold them in your hand while burning, with as much safety as a candle; and if you put your hand within a foot of the mouth of the case, you will feel the sparks like drops of rain. When any of these spur-fires are fired singly, they are called artificial flower pots; but some of them placed round a transparent pyramid of paper, and fired in a large room, make a very pretty appearance.

The

The Composition for the SPUR- FIRE.

Saltpetre four pound eight ounces,
sulphur two pound, and lamp-black one
pound eight ounces.

48

Or, saltpetre one pound, sulphur half
a pound, and lamp-black four quarts.

As the spur-fire composition is very
difficult to mix, and the manner of do-
ing it quite different from any other, I
shall here treat of it separately; for ex-
ample, the saltpetre and the brimstone
must be first sifted together, and then
put into a marble mortar, and the lamp-
black with them, which you work down
by degrees, with a wooden pestle, till
all the ingredients appear of one colour,
which will be something greyish, but
very near black; then drive a little into
a case for tryal, and fire it in a dark
place; and if the sparks, which are
called stars, or pinks, come out in clus-
ters, and afterwards spread well with-
out any other sparks, it is a sign of its
being good, otherwise not; for if any
drossy sparks appear, and the stars not
full.

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full, it is then not mixed enough; but if the pinks are very small, and soon break, it is a sign that you have rubbed it too much.

N. B. This mixture, when rubbed too much, will be too fierce, and hardly shew any stars at all; and, on the contrary, when not mixed enough, will be too weak, and throw forth an obscure smoke, and lumps of dross, without any stars. The reason of this charge being called the spur-fire, is because the sparks it yields have a great resemblance to the rowel of a spur, from whence it takes it's name.

Characters, or significant Signs, for distinguishing the different Ingredients used in Fireworks.

Meal Powder	_____	_____	M
Corned Powder	_____	_____	3
Saltpetre	_____	_____	⊖
Brimstone	_____	_____	Z
Crude Sulphur	_____	_____	C Z
Charcoal	_____	_____	C +
Sea Coal	_____	_____	C S
Saw-dust or Beech-raspings	_____	_____	B R
			Steel

Steel or Iron-filings	_____	S x
Brafs-duft	_____	B x
Glaſs-duft	_____	G x
Tanners-duft of Bark	_____	T x
Caſt Iron	_____	C I
Antimony Crude	_____	C A
Camphor	_____	x
Yellow Amber	_____	A Y
Lapis Calaminaris	_____	L S
Gum	_____	o
Lamp Black	_____	B L
Iſing Glaſs	_____	G I
Spirit of Wine	_____	W
Spirits of Turpentine	_____	S T
Oil of Spike	_____	P O

The uſe of the above characters is, that by the help of them, the different receipts may be contracted to ſo ſmall a compaſs, that they may all be contained in one leaf of a pocket book, which is much leſs than any table that has yet been invented. Theſe ſigns are alſo very convenient for thoſe who travel.

How

How to meal GUN-POWDER, BRIM-
STONE, and CHARCOAL.

There have been many methods used to grind these ingredients to a powder for fireworks, such as large mortars and pestles, made of ebony, and other hard wood; likewise horizontal mills with brass barrels; but none of these methods has proved so effectual and speedy as the last invention, that of the mealing table, which is represented in Plate I. Fig. I. This table is made of elm, with a rim round its edge, four or five inches high; and at the narrow end, A, is a slider, which runs in a groove and forms part of the rim; so that when you have taken out of the table, as much powder as you conveniently can, with the copper shovel Fig. 2. you may sweep all clean out at the slider A. When you are going to meal a quantity of powder, observe not to put too much in the table at once; but when you have put in a good proportion, take the muller Fig. 3. and rub it therewith till all the grains are broke, then scarce it, in a lawn sieve
I that

that has a receiver and top to it; and that which does not pass through the sieve, return again to the table and grind it more, till you have brought it all fine enough to go through the sieve. Brimstone and charcoal are ground in the same manner as gun-powder, only the muller must be made of ebony, for these ingredients being harder than powder, would stick in the grain of elm, and be very difficult to grind; and as the brimstone is apt to stick and clod to the table, it would be best to keep one for that purpose only, by which means you will always have your brimstone clean and well ground.

To prepare CAST-IRON for Gerbes,
White Fountains, and Chinese
Fire.

Cast-iron being of so hard a nature, as not to be cut by a file, we are obliged to make use of the following method to reduce it into grains, though somewhat difficult to perform; but if we consider what beautiful sparks this sort of iron yields, no pains should be spared to granulate such an essential material, to do
which

which you must proceed thus : get at an iron foundry some thin pieces of iron, such as generally runs over the moulds, at the time of casting : then have a square block made of cast iron, and a square hammer of the same metal, about four pound weight ; then, having covered the floor with cloth, or something to catch the beatings, lay the thin pieces of iron on the block, and beat them thereon with the hammer, till you have reduced them into small grains, which afterwards searce with a very fine sieve, in order to separate from them the fine dust, which is sometimes used in small cases of brilliant fire, instead of steel dust ; and when you have got out all the dust, sift what remains with a sieve a little larger, and so on with sieves of different sizes, till the iron will pass through about the bigness of small bird shot : your iron being thus beat and sifted, put each sort into wooden boxes or oiled paper, to keep it from getting rust. When you use any of this iron, observe that you make a difference in its size, in proportion to the cases for which the charge is intended ; for the coarse sort

D

.of

of it is only designed for very large gerbes, of six or eight pound weight.

Charges for Sky-Rockets, &c:

For Rockets of Four Ounces.

Mealed powder one pound four ounces, saltpetre four ounces, and charcoal two ounces.

For Rockets of Eight Ounces.

I. Meal powder one pound, saltpetre four ounces, brimstone three ounces, and charcoal one ounce and a half.

II. Meal powder one pound and a half, and charcoal four ounces and a quarter.

For Rockets of One Pound.

X Meal powder two pound, saltpetre eight ounces, brimstone four ounces, charcoal two ounces, and steel filings one ounce and a half.

X *This is two wrong for
my mould of 1 pound* For

For Sky Rockets in general.

I. Saltpetre four pound, brimstone one pound, and charcoal one pound and a half.

II. Saltpetre four pound, brimstone one pound and a half, charcoal one pound twelve ounces, and meal powder two ounces.

For large Sky Rockets.

Saltpetre four pound, meal powder one pound, and brimstone one pound.

The following Compositions may be used for Rockets of a midling size.

I. Saltpetre eight pound, sulphur three pound, meal powder three pound.

II. Saltpetre three pound, sulphur two pound, meal powder one pound, charcoal one pound.

Compositions for Rocket Stars.

For White Stars.

Meal powder four ounces, saltpetre twelve ounces, sulphur vivum six ounces, oil of spike two ounces, and camphor five ounces.

For Blue Stars.

Meal powder eight ounces, saltpetre four, sulphur two, spirits of wine two, and oil of spike two.

Coloured, or variegated Stars.

Meal powder eight drams, saltpetre four ounces, sulphur vivum two ounces, and camphor two ounces.

For Brilliant Stars.

Saltpetre three ounces and a half, sulphur an ounce and a half, and meal powder three quarters of an ounce. This composition must be worked up with spirits of wine only.

For

For Common Stars.

Saltpetre one pound, brimstone four ounces, antimony four ounces and three quarters, isinglass half an ounce, camphor half an ounce, and spirits of wine three quarters of an ounce.

For Tailed Stars.

Meal powder three ounces, brimstone two ounces, saltpetre one ounce, and charcoal (coarsely ground) three quarters of an ounce.

For Drove Stars.

I. Saltpetre three pound, sulphur one pound, brass dust twelve ounces, and antimony three ounces.

II. Saltpetre one pound, antimony four ounces, and sulphur eight.

For fix'd Pointed Stars.

Saltpetre eight ounces and an half, sulphur two ounces, and antimony one ounce and ten drams.

D 3

Stars

Stars of a fine Colour.

Sulphur one ounce, meal powder one ounce, saltpetre one ounce, camphor four drams, oil of turpentine four drams.

Gold Rain for Sky Rockets.

I. Saltpetre one pound, meal powder four ounces, sulphur four ounces, brass dust one ounce, saw dust two and a quarter, and glass dust six drams.

II. Meal powder twelve ounces, saltpetre two ounces, and charcoal four.

III. Saltpetre eight ounces, brimstone two ounces, glass dust one ounce, antimony three quarters of an ounce, brass dust a quarter of an ounce, and saw dust twelve drams.

Silver Rain.

I. Saltpetre four ounces, sulphur, meal powder, and antimony, of each two ounces, and half an ounce of sal prunellae.

II. Saltpetre half a pound, brimstone two ounces, and charcoal four.

III. Salt-

III. Saltpetre one pound, brimstone a quarter of a pound, and antimony six ounces.

IV. Saltpetre four ounces, brimstone one ounce, powder two ounces, and steel dust three quarters of an ounce.

For Water Rockets.

I. Meal powder six pound, saltpetre four pound, brimstone three pound, and charcoal five pound.

II. Saltpetre one pound, brimstone four ounces and a half, and charcoal six ounces.

III. Saltpetre one pound, brimstone four ounces, and charcoal twelve ounces.

IV. Saltpetre four pound, brimstone one pound eight ounces, and charcoal one pound twelve ounces.

V. Brimstone two pound, saltpetre four pound, and meal powder four pound.

VI. Saltpetre one pound, meal powder four ounces, brimstone eight ounces and a half, and charcoal two ounces.

VII. Meal powder one pound, saltpetre three pound, brimstone one pound, seacoal one ounce, charcoal eight ounces and a half, saw dust three quarters of

an ounce, steel dust half an ounce, and coarse charcoal a quarter of an ounce.

VIII. Meal powder one pound twelve ounces, saltpetre three pound, sulphur one pound eight ounces, charcoal twelve ounces, saw dust two ounces.

A sinking Charge for Water Rockets.

Meal powder eight ounces, charcoal three quarters of an ounce.

For Wheel Cases, from two Ounces to four Pound.

I. Meal powder two pound, saltpetre four ounces, and iron filings seven ounces.

II. Meal powder two pound, saltpetre twelve ounces, sulphur four, and steel dust three ounces.

III. Meal powder four pound, saltpetre one pound, brimstone eight ounces, and charcoal four ounces and a half.

IV. Meal powder eight ounces, saltpetre four, saw dust one ounce and a half, and sea coal three quarters of an ounce.

V. Meal

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V. Meal powder one pound four ounces, brimstone four ounces ten drams, saltpetre eight ounces, glass dust two ounces and a half.

VI. Meal powder twelve ounces, charcoal one ounce, saw dust half an ounce.

VII. Saltpetre one pound nine ounces, brimstone four ounces, and charcoal four ounces and a half.

VIII. Meal powder two pound, saltpetre one pound, brimstone half a pound, and sea coal two ounces.

IX. Saltpetre two pound, brimstone one pound, meal powder four pound, and glass dust four ounces.

X. Meal powder one pound, saltpetre two ounces, and steel dust three ounces and a half.

XI. Meal powder two pound, and steel dust two ounces and a half, with two ounces and a half of the fine dust of beat iron.

XII. Saltpetre eleven pound thirteen ounces, brimstone eight ounces, and charcoal six ounces.

A flow

A flow Fire for Wheels.

I. Saltpetre four ounces, brimstone two ounces, and meal powder one ounce and a half.

II. Saltpetre four ounces, brimstone one ounce, and antimony one ounce fix drams.

III. Saltpetre four ounces and a half, brimstone one ounce, and mealed powder one ounce and a half.

A dead Fire for Wheels.

Saltpetre one ounce and a quarter, brimstone a quarter of an ounce, lapis-calaminaris a quarter of an ounce, and antimony two drams.

For standing or fixed Cafes.

I. Meal powder four pound, saltpetre two pound, brimstone and charcoal one pound.

II. Meal powder two pound, saltpetre one pound, and steel dust eight ounces.

III. Meal powder one pound four ounces, and charcoal four ounces.

IV. Meal

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IV. Meal powder one pound, and steel dust four ounces.

V. Meal powder two pound and a half, brimstone four ounces, and sea-coal six ounces.

VI. Meal powder three pound, charcoal five ounces, and saw dust one ounce and a half.

For Sun Cakes.

I. Meal powder eight pound and a half, saltpetre one pound two ounces, steel dust two pound ten ounces and a half, and brimstone four ounces.

II. Meal powder three pound, saltpetre six ounces, and steel dust seven ounces and a half.

For a Brilliant Fire.

Meal powder twelve pound, saltpetre one pound, brimstone four ounces, and steel dust one pound and a half.

For

For Gerbes.

Meal powder six pound, and beat iron two pound one ounce and a half.

Chinefe Fire.

Saltpetre twelve ouces, meal powder two pound, brimstone one pound two ounces, and beat iron twelve ounces.

Charges for Tourbillons.

For four ounce Tourbillons.

Meal powder two pound four ounces, and charcoal four ounces and a half.

For eight ounce Tourbillons.

Meal powder two pound, and charcoal four ounces and three quarters.

For

For large Tourbillons.

Meal powder two pound, saltpetre one pound, brimstone eight ounces, and beat iron eight ounces.

N. B. Tourbillons may be made very large, and of different colour'd fires, only you are to observe, that the larger they be, the weaker must be the charge; and, on the contrary, the smaller they be, the stronger must be their charge.

For Water Ballóons.

I. Saltpetre four pound, brimstone two pound, meal powder two pound, antimony four ounces, saw dust four ounces, and glass dust one ounce and a quarter.

II. Saltpetre nine pound, brimstone three pound, meal powder six pound, rosin twelve ounces, and antimony eight ounces.

For Water Squibs.

I. Meal powder one pound, and charcoal one pound.

II. Meal

II. Meal powder one pound, and charcoal nine ounces.

For Mine-ports or Serpents.

I. Meal powder one pound, and charcoal one ounce.

II. Meal powder nine ounces, and charcoal one ounce.

Port-fires for firing Rockets, &c.

I. Saltpetre twelve ounces, brimstone four ounces, and meal powder two ounces.

II. Saltpetre eight ounces, brimstone four ounces, and meal powder two ounces.

III. Saltpetre one pound two ounces, meal powder one pound and a half, and brimstone ten ounces. This composition must be moistened with one gill of linseed oil.

IV. Meal powder six ounces, saltpetre two pound two ounces, and brimstone ten ounces.

V. Saltpetre one pound four ounces, meal powder four ounces, brimstone five ounces, and saw dust eight ounces.

VI. Salt-

VI. Saltpetre eight ounces, brimstone two ounces, and meal powder two ounces.

Port-fires for Illuminations.

Saltpetre one pound, brimstone eight ounces, and meal powder six ounces.

For Cones or Spiral Wheels.

Saltpetre one pound and a half, brimstone six ounces, meal powder fourteen ounces, and glass dust fourteen ounces.

For Crowns or Globes.

Saltpetre six ounces, brimstone two pound, antimony four ounces, and camphor two ounces.

For Air Ballóon / Fuzes.

I. Saltpetre one pound ten ounces, brimstone eight ounces, and meal powder one pound six ounces.

II. Saltpetre one pound and a half, brimstone eight ounces, and meal powder one pound eight ounces.

Serpents

Serpents for Pots des Brins.

Meal powder one pound eight ounces, saltpetre twelve ounces, and charcoal two ounces.

For Fire Pumps.

I. Saltpetre five pound, brimstone one pound, meal powder one pound and a half, and glass dust one pound.

II. Saltpetre five pound eight ounces, brimstone one pound, meal powder one pound eight ounces, and glass dust one pound eight ounces.

For a Slow White Flame.

I. Saltpetre two pound, sulphur three pound, antimony one pound.

II. Saltpetre three pound and a half, sulphur two pound and a half, meal powder one pound, antimony half a pound, glass dust four ounces, brass dust one ounce.

N. B. These compositions, driven one inch and a quarter in a one ounce case, will burn one minute, which is much longer

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longer time than an equal quantity of any composition will last, that has yet been made public.

For Amber Lights.

Meal powder nine ounces, and amber three ounces. This charge may be drove in small cases, for illuminations.

For Lights of another Sort.

Saltpetre three pound, brimstone one pound, meal powder one pound, antimony ten ounces and a half. All these ingredients must be mixed with the oil of spike.

For a Red Fire.

Meal powder three pound, charcoal twelve ounces, and saw dust eight ounces.

For a Common Fire.

Saltpetre three pound, charcoal ten ounces, and brimstone two ounces.

E

To

To make an Artificial Earthquake.

Mix the following ingredients to a paste with water, and then bury it in the ground, and in a few hours the earth will break and open in several places. The composition: Sulphur four pound, and steel dust four pound.

Having laid down, under the preceding heads, the different compositions used in fireworks by our modern artists; I shall, in the next place, give some tables of charges that were formerly used, according to the several accounts given by those authors from whom they are collected: but if the reader will consider, he will find the charges in these tables to be very uncertain, by comparing their method of determining the size and weight of rockets, and the proportions of ingredients thereto, with the method taught in this work, which is so plain, easy, and certain, that I have never yet known it fail; and doubt not, but that it will be so allowed by all who chuse to make a tryal thereof.

The

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The subsequent table is taken from Siemienowicz, wherein is specified the different charges of sky rockets, from half an ounce to one hundred pound; the charges being calculated in proportion to the weight of a leaden ball of the same diameter as the bore of each mould; which bores are divided into inches and lines *, and each line into twelve equal parts, according to the French method.

* A line is the twelfth part of an inch..

E 2

Weight

T A B. I.

Weight of the ball.	Diameter of the mould.			pow- der.	Salt- petre	Brim stone	char- coal.
lb. oz.	in.	l.	pts	lb.oz.	lb.oz.	lb.oz.	lb.oz.
$\frac{1}{2}$	0	6	3	0 15	0 0	0 0	0 2
1	0	7	8				
2	0	9	7				
3	0	11	0	0 12	0 2	0 $\frac{1}{2}$	0 $1\frac{1}{2}$
4	1	0	1				
5	1	1	0				
6	1	1	10	1 3	0 12	0 4	0 $1\frac{1}{2}$
7	1	2	7				
8	1	3	4				
9	1	3	11				
10	1	4	5				
11	1	5	0				
12	1	5	5				
13	1	6	0				
14	1	6	5				
16	1	7	3	18 0	8 0	2 0	4 0
2 0	2	0	3				
3 0	2	3	7				
4 0	2	6	9	0 0	60 0	2 0	15 0
5 0	2	8	8				
6 0	2	10	9				
8 0	3	2	6	0 0	35 0	5 0	10 0
10 0	3	5	4				
12 0	3	7	10				
15 0	3	11	4	0 0	32 0	8 0	16 0
17 0	4	1	5				
20 0	4	4	2				
27 0	4	9	9	0 0	64 0	12 0	16 0
30 0	4	11	6				
40 0	5	5	1				
60 0	6	3	3	0 0	30 0	7 0	18 0
100 0	7	5	3				

T A B.

T A B. II.

The following table is taken from a late French author *, whose method of regulating the charges is according to the interior diameter of the mould, which he divides into lines.

Interior diameter of the mould.	Weight of the rocket.	Saltpe- tre.	Brim- stone.	Char- coal.
Lines.	lb. oz. dr.	ounces.	ounces.	ounces.
6	0 0 4	44	4	16
7	0 0 6			
8	0 1 1			
9	0 1 5	40	4	16
10	0 2 2			
11	0 3 0			
12	0 3 7	38	4	16
13	0 4 6			
14	0 6 1			
15	0 7 4	36	4	16
16	0 9 1			
17	0 11 0			
18	0 13 1	34	4	16
19	0 15 4			
19 $\frac{1}{4}$	1 0 0			
21	1 7 1	32	5	16
24	1 15 1			
30	4 0 0			
36	6 9 0	30	6	18
72	55 8 0			

* Traité des feux d'artifice, par M. F***.

T A B. III.

A table of charges for sky-rockets in which the charges are adapted in proportion to the weight of composition contained in each rocket, after the method of Hanzelet.

Weight of composition.	Powder	Saltpe- tre.	Brim- stone.	Char- coal.
lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
0 1 $\frac{1}{2}$	0 4			0 1
or,	1 0	0 1 $\frac{1}{2}$		0 1 $\frac{1}{2}$
0 2	0 4	0 1		
or,	0 4			0 $\frac{1}{2}$
0 4	1 0	0 4		0 4
0 8				
or,	0 3	0 10	0 1	0 3
	0 10	0 3 $\frac{1}{2}$	0 1	0 3 $\frac{1}{2}$
1 0	1 0		0 1	0 2
or,		1 4	0 2	0 3 $\frac{1}{2}$
3 0		1 14	7 7 $\frac{1}{2}$	0 11
6 0	}	31 0	4 8	10 0
7 0				
8 0		8 0	1 8	2 12
10 0	}			

T A B. IV.

A table collected from Henrion, whose method of adjusting the charges is the same as in the preceding table.

Weight of composition.	Powder	Saltpe- tre.	Brim- stone.	Char- coal.
lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
1				
2	1 0			0 2
or,	1 0	1 0		0 1
3	4 $\frac{1}{2}$	0 1		0 1
4				
8	4 0	1 0	0 $\frac{1}{2}$	0 4
	1 8	0 4		0 2
or,	1 0	0 4		0 1
	3 $\frac{1}{2}$	0 10		0 3 $\frac{1}{2}$
8			0 2	
	2 5	0 0	steel dust	0 6
10			0 2	
12	17 0	0 4	0 3 $\frac{1}{2}$	0 7
14			0 3	
	2 8	0 9	steel dust	0 3
15			0 3	
1	0	0 0	0 1	0 3
2	0 2	0 12	0 1	0 3
3			1 4	
	0 0	8 0	steel dust	2 2
10			0 2	

T A B. V.

A table of charges for sky rockets, taken from the Memoires D'Artillerie de M. de Saint Remy, with improvements by M. F * * *.

Composition for a rocket of two pound.	Composition for a rocket of one pound.	Composition for a rocket of half a pound.	Composition for a rocket of four ounces.	Composition for a rocket of one ounce and a half.
Corrected by M. F * * *, one pound.	Corrected, eleven ounces.	Corrected, seven ounces and a half.	Corrected, six ounces five drams.	Corrected, one ounce five drams.
lb. oz.	lb. oz.	lb. oz.	oz.	oz.
Pow. 2 0	1 0	1 4	5	8 or 9
Saltp. 1 0	12	12	1	$\frac{1}{3}$
Brimst. 5	2	1	$\frac{1}{4}$	$\frac{1}{2}$ or 1
Charc. 4		3	$\frac{1}{2}$	
Steel-d. 2		2		
Height of the mould, nine inches and a half.	Height of the mould, eight inches and a half.	Height of the mould, seven inches and a half.	Height of the mould seven inches.	Height of the mould, four inches and a half.
Diameter of the mould, one in. seven lines.	Diameter of the mould, one inch five lines.	Diameter of the mould, one inch three lin.	Diameter of the mould, one inch two lines.	Diameter of the mould, nine lines.

French Names for Sky Rockets.

Double Mar- quise.	Marquise.	Grosse de partement.	De parlement.	Fusée de Caïsse.
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Remarks

Remarks on the foregoing Tables.

In table the first, we find that the compositions for all rockets under one pound are made chiefly of gun-powder and charcoal, which method has been long proved erroneous in many respects : first, that rockets made with such charges will not keep long without spoiling ; secondly, that they are very uncertain in performing their proper effect ; thirdly, they will carry but a short tail, with a black and smoaky fire.

We also find those charges for rockets above one pound, that are composed of saltpetre, brimstone, and charcoal, to be too strong ; by which we should imagine that, at the time when they were used, the piercers did not bear the same proportion to the rockets, as those made use of by our present artists ; for it is on the size of the cavity in the composition, that the effect of the rocket and proportion of the charge depends : which we shall endeavour to shew hereafter.

Table the second is given, by the author, as an improvement on the first ; wherein he takes notice of the charges
being

being too many in number ; he has therefore reduced them to seven only, which, according to his opinion, are sufficient for rockets of any size : he also observes, that the ingredients are expressed in unequal quantities ; which he has likewise laid down in a more regular order. By the same author's account, rockets were made in France, not many years since, with the compositions mentioned in his table. I shall not here pretend to say, that rockets were not made with the charges given in the above-mentioned table ; yet can affirm, by practice and experience, that several of them will not agree with our present moulds.

As to the method prescribed in the third and fourth tables, it is difficult to determine whether we shall praise or condemn it, as they were wrote when the art of making fireworks was in it's infancy ; as may be seen by their strange method of determining the proportion of ingredients, and weight of rockets, by the quantity of composition contained in each case ; which must have required a very nice calculation, for at that time, they had not fixed upon an exact length for rockets, but made them
from

from six to nine diameters long: all which differ so much from our modern practice, that I never thought it worth the trouble of making a trial: but am of opinion, that very few of the charges will answer.

In table the fifth, the compositions are in proportion to the weight of the rocket, with it's head and stick, all compleat; which head and stick together are equal to the weight of the rocket, according to the improvement made by M. F***, as may be seen by the second column from the top; he also has added the diameters to the moulds, in proportion to their height, allowing each six diameters, which supposing to be right, the rockets will be nearly reduced to half their weight given in the first column. On the charges in this table I have made no experiment, therefore cannot recommend them as proof.

Having already given a variety of charges for sky-rockets, in the preceding tables, which are collected from the principal authors on this subject, together with remarks on the same; I shall, in the next place, according to my promise

mise of not omitting any thing that may be of service to the reader, add some compositions for rocket-stars of several colours, as inserted by former authors.

Compositions for Stars of different Colours.

I. Meal powder four ounces, saltpetre two ounces, brimstone two ounces, steel dust one ounce and a half, and camphor, white amber, antimony, and mercury-sublimate, of each half an ounce.

II. Rochepetre ten ounces, brimstone, charcoal, antimony, meal powder, and camphor, of each three quarters of an ounce, moistened with oil of turpentine. These compositions are made into stars, by being worked to a paste with aqua vitæ, in which has been dissolved some gum-tragacanth; and after you have roll'd them in powder, make a hole through the middle of each, and string them on quick-match, leaving about two inches from one to the other.

III. Saltpetre eight ounces, brimstone two ounces, yellow amber one ounce, antimony one ounce, and powder three ounces.

IV. Brim-

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IV. Brimstone two ounces and a half, saltpetre six ounces, olibanum or frankincense in drops four ounces; mastick, and mercury-sublimate, of each four ounces; meal powder five ounces; white amber, yellow amber, and camphor, of each one ounce; antimony and orpiment half an ounce each.

V. Saltpetre one pound, brimstone half a pound, and meal powder eight ounces, moistened with potrolio-oil.

VI. Powder half a pound, brimstone and saltpetre, of each four ounces.

VII. Saltpetre four ounces, brimstone two ounces, and meal powder one ounce.

For Stars that carry Tails of sparks.

I. Brimstone six ounces, antimony crude two ounces, saltpetre four ounces, and rosin four ounces.

II. Saltpetre, rosin, and charcoal, of each two ounces; brimstone one ounce, and pitch one ounce.

These compositions are sometimes melted in an earthen pan, and mixed with chopped cotton match, before they

are rolled into stars, but will do as well if wetted, and worked up in the usual manner.

Another Sort of Stars, which yield some Sparks.

I. Camphor two ounces, saltpetre one ounce, meal powder one ounce.

II. Saltpetre one ounce, ditto melted half an ounce, and camphor two ounces. When you would make stars of either of these compositions, you must wet them with gum water, or spirit of wine, in which has been dissolved some gum-arabick, or gum-tragacanth, that the whole may have the consistence of a pretty thick liquid; having thus done, take one ounce of lint, and stir it about in the composition till it becomes dry enough to roll into stars.

For Stars of a yellowish Colour.

Take four ounces of gum-tragacanth or gum-arabick, pounded and sifted thro' a fine sieve, camphor dissolved in brandy two ounces, saltpetre one pound, sulphur
half

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half a pound, coarse powder of glass four ounces, white amber one ounce and a half, and orpiment two ounces. All these ingredients being well incorporated, make them into stars after the common method.

Stars of another Sort.

Take a pound of camphor and melt it in a pint of spirit of wine over a slow fire; then add to it a pound of gum-arabick that has been dissolved; with this liquor, mix one pound of saltpetre, six ounces of sulphur, and five ounces of meal powder; and after you have stirred them well together, roll them into stars proportionable to the rockets for which you intend them.

Of the Colours produced by the different Compositions.

As variety of fires adds greatly to a collection of works, it is necessary that every artist should know the different effect of each ingredient; for which reason, I shall here explain the colours they

they produce of themselves ; and likewise how to make them retain the same when mixed with other bodies : as for example, sulphur gives a blue, camphor a white or pale colour, saltpetre a clear white, yellow amber a colour inclining to yellow, sal-armoniac a green, antimony a reddish, rosin a copper colour, and greek-pitch a kind of bronze or between red and yellow. All these ingredients are such as shew themselves in a flame, viz.

For a white Flame.

Saltpetre, sulphur, meal powder, and camphor, the saltpetre must be the chief part.

For a blue Flame.

Meal powder, saltpetre, and sulphur vivum, the sulphur must be the chief part : or, meal powder, saltpetre, brimstone, spirit of wine, and oil of spike ; but let the powder be the principal part.

For

For a Flame inclining to Red.

Saltpetre, sulphur, antimony, and greek-pitch, the saltpetre the chief part.

By the above method may be made various colours of fire, as the practitioner pleases; for, by making a few trials, he may cause any ingredient to be predominant in colour.

Of such Ingredients as shew themselves in Sparks when rammed in choaked Cases.

The set colours of fire produced by sparks are divided into four sorts, viz. the black, white, grey, and red; the black charges are composed of two ingredients, which are meal powder and charcoal; the white of three, viz. saltpetre, sulphur, and charcoal; the grey of four, viz. meal powder, saltpetre, brimstone, and charcoal; and the red of three, viz. meal powder, charcoal, and saw dust.

There are, besides these four regular or set charges, two others, which are distinguished

F

guished by the names of compound and brilliant charges ; the compound charge being made of many ingredients, such as meal powder, saltpetre, brimstone, charcoal, saw dust, seacoal, antimony, glass dust, brass dust, steel filings, cast iron, tanner's dust, &c. or any thing that will yield sparks ; all which must be managed with discretion. The brilliant fires are composed of meal powder, saltpetre, brimstone, and steel dust ; or with meal powder and steel filings only.

How to make Cotton Quick-match.

Quick-match is generally made of such cotton as is put in candles, of several sizes, from one to six threads thick, according to the pipes it is designed for, which pipe must be large enough for the match, when made, to be pushed in easily without breaking it. Having doubled the cotton into as many threads as you think proper, coil it very lightly into a flat-bottomed copper or earthen pan ; then put in the saltpetre and the liquor, and boil them together about twenty minutes ; after which, coil it again into another pan, as is shewn in Fig. 4. and
pour

pour on it what liquor remains; then put in some meal powder, and press it down with your hands, till it is quite wet; afterwards place the pan before the wooden frame, Fig. 5, which must be suspended by a point in the center of each end; and place yourself before the pan, tying the upper end of the cotton to the end of one of the sides of the frame.

When every thing is thus got ready, you must have one to turn the frame round, while you let the cotton pass through your hands, holding it very lightly, and at the same time keeping your hands full of the wet powder; but if the powder should be too wet to stick to the cotton, put more in the pan, so as to keep a continual supply till the match is all wound up; you may wind it as close on the frame as you please, so that it does not stick together; when the frame is full, take it off the points, and sift dry meal powder on both sides the match, till it appears quite dry: in winter the match will be a fortnight before it is fit for use; when it is thoroughly dry, cut it along the outside of one of the sides

of the frame, and tie it up in skains for use.

N. B. The match must be wound tight on the frames.

Ingredients for the Match.

Cotton one pound twelve ounces, salt-petre one pound, spirit of wine two quarts, water three quarts, isinglass three gills, and meal powder ten pound. To dissolve four ounces of isinglass, take three pints of water.

 S E C T. III.

Of Sky-rocket Moulds.

AS the performance of rockets depends much on their moulds, it is requisite to give a definition of them and their proportions, which are as follows: They are made and proportioned by the diameter of their orifice, which is divided into six equal parts: as for example, Fig. 6. represents a mould made by its diameter A B, its height from C to D is six diameters and two thirds; from D to E is the height of the foot, which is one diameter and two thirds; F the choak, or cylinder, whose height is one diameter and one third; it must be made out of the same piece as the foot, and fit tight in the mould; G an iron pin that goes through the mould and cylinder, to keep the foot fast; H the nipple, which is half a diameter high, and two thirds thick, and of the same

F 3

piece

piece of metal as the piercer I, whose height is three diameters and a half, and at the bottom is one third of the diameter thick, and from thence tapering to one sixth of the diameter: the best way to fix the piercer in the cylinder, is to make that part below the nipple long enough to go quite through the foot, and rivet it at the bottom. Fig. 7. is a former or rowler for the cases, whose length, from the handle, is seven diameters and a half, and its diameter two thirds of the bore A B; 8. the end of the former, which is of the same thickness and one diameter and two thirds long, the small part; which fits into the hole in the end of the rowler when the case is pinching, is one sixth and a half of the mould's diameter thick. Fig. 9. the first drift, which must be six diameters from the handle, and this as well as all other rammers must be a little thinner than the former, to prevent the facking of the paper, when you are driving in the charge: in the end of this rammer is a hole to fit over the piercer; the line K marked on this is two diameters and one third from the handle, so that when you are filling the
rocket,

rocket, this line appears at top of the case; you must then take the second rammer, 10, which from the handle is four diameters; and the hole for the piercer is one diameter and a half long. Fig. 11. is the short and solid drift which you use when you have filled the case as high as the top of the piercer.

It is to be observed, that all rammers must have a collar of brass at the bottom, to keep the wood from spreading or splitting; and that the same proportion be given to all moulds, from one ounce to six pound. I mentioned nothing concerning the handles of the rammers; however, if their diameter be equal to the bore of the mould, and two diameters long, it will be a very good proportion; but the shorter you can use them the better, for the longer the drift, the less will be the pressure on the composition, by the blow given with the mallet.

A Table of Dimensions for Rocket Moulds, in which the Rockets are rammed solid.

Weight of rock- ets.	Length of the moulds with- out their feet.	Interior diameter of the moulds.	Height of the nipples.
lb. oz.	Inches.	Inches.	Inches.
6 0	34,7	3,5	1,5
4 0	38,6	2,9	1,4
2 0	13,35	2,1	1,0
1 0	12,25	1,7	0,85
0 8	10,125	1,333 &c.	0,6
0 4	7,75	1,125	0,5
0 2	6,2	0,9	0,45
0 1	4,9	0,7	0,35
0 $\frac{1}{2}$	3,9	0,55	0,25
6 drams	3,5	0,5	0,225
4 drams	2,2	0,3	0,2

The diameter of the nipple must always be equal to that of the former.

I have omitted the thickness of the moulds, it being very immaterial, provided they are substantial and strong.

I would

I would not advise any one who makes rockets for his private amusement, to ram them solid, for it requires a very skilful hand, and an expensive apparatus for boring them, which will be shewn herereafter. Driving of rockets solid is the most expeditious method, but not so certain as ramming them over a piercer, which I have found by experience.

Of Moulds for Wheel Cases, or Serpents.

Fig. 12. represents a mould in which the cases are drove solid; L the nipple *, with a point † at top, which, when the case is filling, serves to stop the neck, and prevent the composition from falling out, which without this point it would do; and, in consequence, the air would get into the vacancy in the charge, and at the time of firing cause the case to burst. These sort of moulds are made

* The nipple and cylinder to bear the same proportion as those for rockets.

† A round bit of brass, equal in length to the nick of the case, and flat at the top.

of any length or diameter, according as the cafes are required, but the diameter of the rollers must be equal to half the bore, and the rammers made quite solid.

How to roll Rocket and other Cafes.

Sky rocket cafes are to be made fix and a half of their exterior diameter long, and all other cafes that are to be filled in' moulds must be as long as the moulds, within half its interior diameter.

Rocket cafes, from the smallest to four or six pound, are generally made of the strongest sort of cartridge paper, and rolled dry; but the large sort are made of pasted paste-board. As it is very difficult to roll the ends of the cafes quite even, the best way will be to keep a pattern of the paper for the different sorts of cafes, which pattern should be somewhat longer than the case it is designed for, and on it marked the number of sheets required, which will prevent any paper being cut to waste: having cut your papers of a proper size, and the

ARTIFICIAL FIREWORKS. 75

the last sheet for each case with a slope at one end, so that when the cases are rolled it may form a spiral line round the outside, and that this slope may always be the same, let the pattern be so cut for a guide : before you begin to roll, fold down one end of the first sheet, so far that the fold will go two or three times round the former ; then, on the double edge, lay the former with its handle off the table, and when you have rolled on the paper, within two or three turns, lay, on that part which is loose, the next sheet, and roll it all on.

Having thus done, you must have a smooth board, about twenty inches long, and equal in breadth to the length of the case ; in the middle of this board must be a handle placed length-ways ; under this board lay your case, and let one end of the board lay on the table ; then press hard on it, and push it forwards, which will roll the paper very tight ; do this three or four times before you roll on any more paper : this must be repeated every other sheet of paper, till the case is thick enough ; but if the rolling board be drawn backwards, it will loosen the paper : you are to observe,
when

when you roll on the last sheet, that the point of the slope be placed at the small end of the roller. Having rolled your case to fit the mould, push in the small end of the former F, about one diameter from the end of the case, and put in the end piece within a little distance of the former; then give the pinching cord one turn round the case, between the former and the end piece; at first pull easy, and keep moving the case, which will make the neck smooth, and without large wrinkles; when the cases are hard to choak, let each sheet of paper (except the first and last, in that part where the neck is formed) be a little moistened with water: immediately after you have struck the concave stroke, bind the neck of the case round with small twine, which must not be tied in a knot, but fastened with two or three hitches.

Having thus pinched and tied the case so as not to give way, put it into the mould without it's foot, and, with a mallet, drive the former hard on the end piece, which will force the neck close and smooth; this being done, cut the case to its proper length, allowing from the neck to the edge of the mouth
half

half a diameter, which is equal to the height of the nipple ; then take out the former, and drive the case over the piercer with the long rammer, and the vent will be of a proper size. Wheel cases must be drove on a nipple with a point, in order to close the neck, and make the vent of the size required ; which, in most cases, is generally one fourth of their interior diameter : as it is very often difficult, when the cases are rolled, to draw the roller out, you may make a hole through the handle, and put in it a small iron pin, by which you may easily turn the former round, and pull it out. Fig. 17. shews the method of pinching cases ; P a treddle, which, when pressed hard with the foot, will draw the cord tight, and force the neck as close as you please ; Q a small wheel or pulley, with a groove round it for the cord to run in.

Cases are commonly rolled wet, for wheels and fixed pieces ; and when they are required to contain a great length of charge, the method of making those sort of cases is as follows : Your paper must be cut as usual, only the last sheet must not be cut with a slope ; having
your

your paper ready, paste each sheet on one side, then fold down the first sheet as before directed, but be careful that the paste does not touch the upper part of the fold, for if the roller be wetted, it will tear the paper in drawing it out : in pasting the last sheet, observe not to wet the last turn or two in that part where it is to be pinched, for if that part be damp, the pinching cord will stick to it, and tear the paper ; therefore, when you choak those cases, roll a bit of dry paper once round the case, before you put on the pinching cord ; but this bit of paper must be taken off after the case is choaked. The rolling board, and all other methods, according to the former directions for the rolling and pinching of cases, must be used to these as well as all other cases.

To make Tourbillon Cases.

Those sorts of cases are generally made about eight diameters long, but if very large, seven diameters will be sufficient : tourbillons will answer very well from four ounces to two pound, but when larger there is no certainty. The cases
are

are best rolled wet with paste, and the last sheet must have a streight edge, so that the case may be all of a thickness: when you have rolled your cases, after the manner of wheel cases, pinch them at one end quite close; then, with the rammer, drive the ends down flat, and afterwards ram in about one third of a diameter of dried clay. The diameter of the former for these cases must be the same as for sky rockets.

N. B. Tourbillons are to be rammed in moulds without a nipple, or in a mould without its foot.

To make Balóón Cases, or Paper Shells.

First you must have an oval former turned of smooth wood; then paste a quantity of brown or cartridge paper, and let it lay till the paste has quite soaked through; this done, rub the former with soap or grease, to prevent the paper from sticking to it; then lay the paper on in small slips, till you have made it one third of the thickness of the shell intended; having thus done, set it
to

to dry, and when dry, cut it round the middle, and the two halves will easily come off; but observe, when you cut, to leave about one inch not cut, which will make the halves join much better than if quite separated; when you have some ready to join, place the halves even together, and paste a slip of paper round the opening to hold them together, and let that dry; then lay on paper all over as before, every where equal, excepting that end which goes downwards in the mortar, which may be a little thicker than the rest; for that part which receives the blow from the powder in the chamber of the mortar consequently requires the greatest strength: when the shell is thoroughly dry, burn a round vent at top, with ~~square~~ iron, large enough for the fuze: this method will do for ballóons from four inches two fifths, to eight inches diameter; but if they are larger, or required to be thrown a great height, let the first shell be turn'd of elm, instead of being made of paper.

For a ballóon of four inches two fifths, let the former be three inches one eighth diameter, and five inches and a half long. For a ballóon of five inches and
a half

a half, the diameter of the former must be four inches, and eight inches long. For a ballóon of eight inches, let the diameter of the former be five inches and fifteen sixteenths, and eleven inches seven eighths long. For a ten inch ballóon, let the former be seven inches three sixteenths diameter, and fourteen inches and a quarter long. The thickness of a shell for a ballóon of four inches two fifths, must be half an inch. For a ballóon of five inches and a half, let the thickness of the paper be five eighths of an inch. For an eight inch ballóon seven eighths of an inch. And for a ten inch ballóon, let the shell be one inch and one eighth thick.

Shells that are designed for stars only, may be made quite round, and the thinner they are at the opening the better; for if they are too strong, the stars are apt to break at the bursting of the shell: when you are making the shell, make use of a pair of calibers, or a round gauge, so that you may not lay the paper thicker in one place than another; and also to know when the shell is of a proper thickness; ballóons must always be made to go easy into the mortars.

G

Of

Of the Method of mixing Compositions.

The performance of the principal part of fireworks depends much on the compositions being well mixed ; therefore great care ought to be taken in this part of the work, particularly in the compositions for sky rockets. When you have four or five pounds of ingredients to mix, which is a sufficient quantity at a time (for a larger proportion will not do so well), first put the different ingredients together, then work them about with your hands, till you think they are pretty well incorporated ; after which put them into a lawn sieve with a receiver and top to it ; and if, after it is sifted, any remains that will not pass through the sieve, grind it again till fine enough ; and if it be twice sifted it will not be amiss ; but the compositions for wheels and common works are not so material, nor need not be so fine. But in all fixed works, from which the fire is to play regular, the ingredients must be very fine, and great care taken
in

in mixing them well together; and observe that, in all compositions wherein are steel or iron filings, the hands must not touch, nor will any works, which have iron or steel in their charge, keep long in damp weather, without being properly prepared, according to the directions given in the following article.

How to preserve Steel or Iron Filings.

It sometimes may happen, that fireworks may be required to be kept a long time, or sent abroad; neither of which could be done with brilliant fires, if made with filings unprepared; for this reason, that the saltpetre being of a damp nature, it causes the iron to rust, the consequence of which is, that when the works are fired, there will appear but very few brilliant sparks, but instead of them a number of red and drossy sparks, and besides, the charge will be so much weakened, that if this should happen to wheels, the fire will hardly be strong enough to force them round: but to prevent such accidents, prepare your filings after the following manner.

G 2

Melt

Melt in a glazed earthen pan some brimstone over a slow fire, and when melted throw in some filings; which keep stirring about till they are covered with brimstone, this you must do while it is on the fire; then take it off, and stir it very quick till cold, when you must roll it on a board with a wooden roller, till you have broke it as fine as corn powder; after which sift from it as much of the brimstone as you can. There is another method of preparing filings, so as to keep two or three months in winter; this may be done by rubbing them between the strongest sort of brown paper, which before has been moistened with linseed oil.

N. B. If the brimstone should take fire, you may put it out, by covering the pan close at top: it is not of much signification what quantity of brimstone you use, so that there is enough to give each grain of iron a coat, but as much as will cover the bottom of a pan, of about one foot diameter, will do for five or six pound of filings: cast iron for gerbes may be preserved by the above method.

The

The Method of Driving or Ramming Sky Rockets, &c.

Rockets which are drove over a piercer must not have so much composition put in them at a time, as when drove solid, for the piercer, taking up great part of the bore of the case, would cause the rammer to rise too high; so that the pressure of it would not be so great on the composition, nor would it be drove every where equal: to prevent which, observe the following rule; that for those rockets, that are rammed over a piercer, let the ladle * hold as much composition as when drove, will raise the drift one half the interior diameter of the case, and for those drove solid to contain as much as will raise it half the exterior diameter of the case: ladles are generally made to go easy in the case, and the length of the scoop about one and a half of its own diameter.

The charge of rockets must always be drove one diameter above the piercer,

* A copper scoop with a wooden handle.

and on it must be rammed one third of a diameter of clay, through the middle of which bore a small hole to the composition, in order that, when the charge is burnt to the top, it may communicate its fire, through the hole, to the stars in the head: great care must always be taken, to strike with the mallet, and with an equal force, the same number of strokes to each ladle-ful of charge; otherwise the rockets will not rise with an uniform motion, nor will the composition burn equal and regular; for which reason they cannot carry a proper tail, for it will break before the rocket has got half way up; instead of reaching from the ground to the top, where the rocket breaks and disperses the stars, rains, or whatever is contained in the head. When you are ramming, keep the drift constantly turning or moving; and when you use the hollow rammers, knock out of them the composition now and then, or the piercer will split them: to a rocket of four ounces, give to each ladle-ful of charge sixteen strokes: ~~X~~ to a rocket of one pound, twenty eight: to a two pounder, thirty-six: to a four pounder

*To a Rocket of eight ounces give
twenty one strokes*

pounder forty-two : and to a six pounder fifty strokes ; but rockets of a larger sort cannot be drove well by hand, but must be rammed with a machine made in the same manner as those for driving piles, which are so very common to be seen, that I shall here omit giving a description of them.

The method of ramming of wheel cases, or any other sort, in which the charge is drove solid, is much the same as sky rockets ; for the same proportion may be observed in the ladle, and the same number of strokes given, according to their diameters, all cases being distinguished by their diameters ; in this manner, a case whose bore is equal to a rocket of four ounces is called a four ounce case, and that which is equal to an eight ounce rocket an eight ounce case, and so on, according to the different rockets.

Having taught the method of ramming cases in moulds ; we shall here say something concerning those filled without moulds, which method, for strong pasted cases, will do extremely well, and save the expence of making so many moulds. The reader must here

observe, when he fills any sort of cases, to place the mould on a perpendicular block of wood, and not on any place that is hollow, for we have found by experience, that when cases were rammed on driving benches, which were formerly used, the works frequently miscarried, on account of the hollow resistance of the benches, which often jarred and loosened the charge in the cases; but this accident has never happened since the driving blocks* have been used.

When cases are to be filled without moulds, proceed thus; have some nipples made of brass or iron, of several sorts and sizes, in proportion to the cases, and to screw or fix in the top of the driving block; when you have fixed in a nipple, make, at about one inch and a half from it, a square hole in the block, six inches deep and one inch diameter; then have a piece of wood, six inches longer than the case intended to be filled and two inches square; on one side of it cut a groove almost the length

* A piece of hard wood in the form of an anvil block.

of the case, whose breadth and depth must be sufficient to cover near half the case; then cut the other end to fit the hole in the block, but take care to cut it so that the groove may be of a proper distance from the nipple: this half mould being made and fixed tight in the block, cut, in another piece of wood nearly of the same length as the case, a groove of the same dimensions as that in the fixed piece; then put the case on the nipple, and with a cord tie it and the two half moulds together, and your case will be ready for filling.

The dimensions of the above described half moulds, are proportionable for cases of eight ounces; but notice must be taken, that they differ in size in proportion to the cases.

Note, the clay, mentioned in this article, must be prepared after this manner; get some clay, in which there is no stones nor sand, and bake it in an oven till quite dry; then take it out and beat it to a powder, and afterwards sift it through a common hair sieve, and it will be fit for use.

Of the Proportion of Mallets.

The best wood for mallets is dry beech, though some have preferred other sorts of wood, and have likewise pretended to determine their exact weight, which is not of much signification; however, for the better instruction of those who have not made a great progress in this art, I shall here give a good proportion for mallets; but at the same time would have every practitioner know, that if he makes use of a common mallet, of a moderate size, in proportion to the rocket, according to his judgment, and if that rocket succeeds, he may depend on the rest, by using the same mallet; yet it will be necessary that cases of different sorts be drove with mallets of different sizes.

The following proportion of the mallets for rockets of any size, from one ounce to six pound, may be observed; but as rockets are seldom made less than one ounce, or larger than six pound, I shall leave the management of them to the curious; but all cases under one ounce, may be rammed with an ounce
rocket

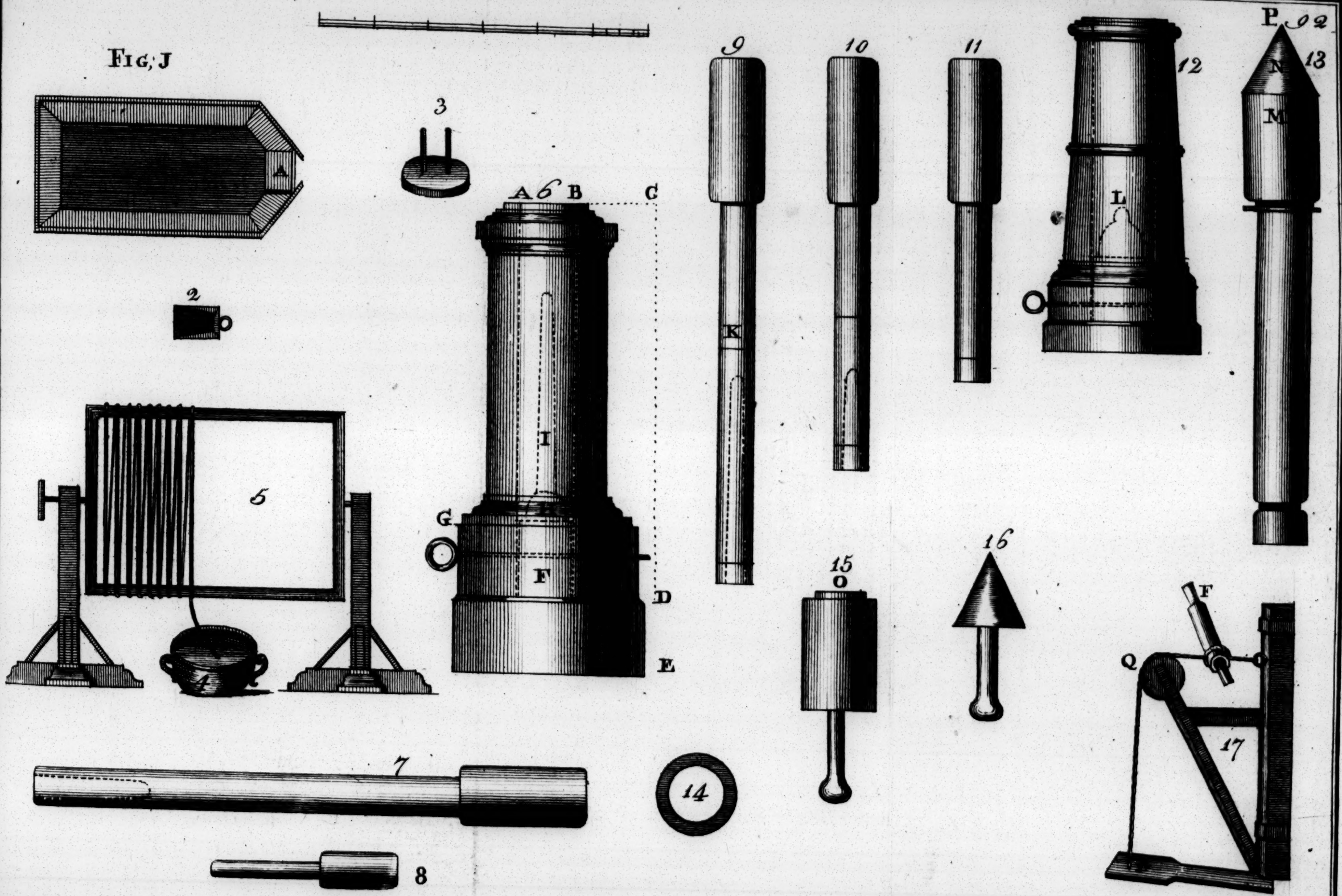
rocket mallet. Your mallets will strike more solid, by having their handles turned out of the same piece as the head, and made in a cylindrical form: let their dimensions be worked by the diameters of the rockets: for example; let the thickness of the head be three diameters, and its length four, and the length of the handle five diameters, whose thickness must be in proportion to the hand.

Of the Proportion of Sky Rockets, with the Manner of heading them.

Fig. 13. represents a rocket compleat without its stick, whose length from the neck is five diameters one sixth; the cases should always be cut to this length after they are filled: M the head, which is two diameters high, and one diameter one sixth and a half in breadth; N the cone or cap, whose perpendicular height must be one diameter one third. Fig. 14. is the collar to which the head is fixed; this is turned out of deal or any light wood, and its exterior diameter

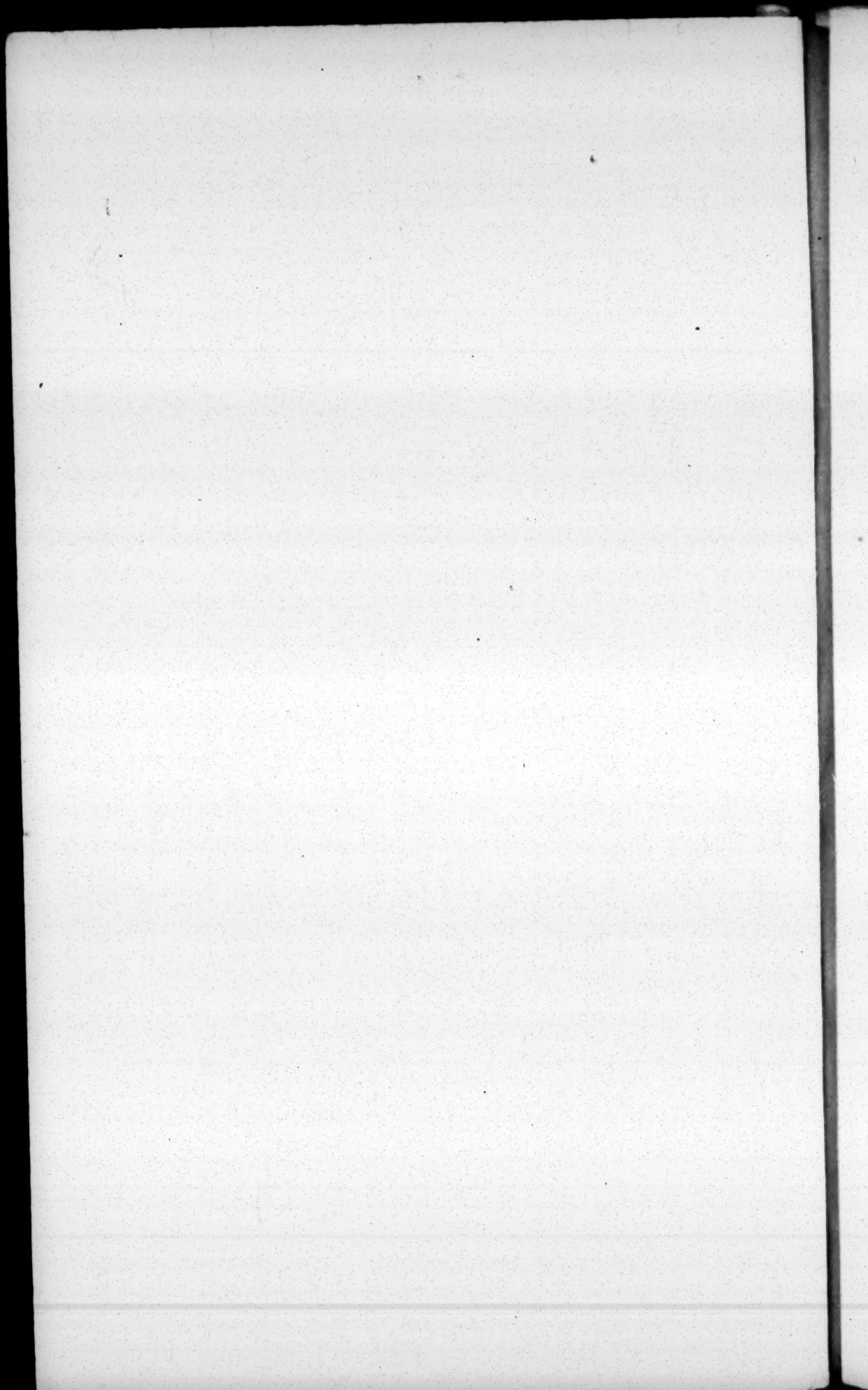
ter must be equal to the interior diameter of the head; one sixth will be sufficient for its thickness, and round the outside edge must be a groove; the interior diameter of the collar must not be quite so wide as the exterior diameter of the rocket; when this is to be glued on the rocket, you must cut two or three rounds of paper off the case, which will make a shoulder for it to rest upon. Fig. 15, a former for the head; two or three rounds of paper well pasted will be enough for the head, which, when rolled, put the collar on that part of the former marked O, which must fit the inside of it; then with the pinching cord, pinch the bottom of the head into the groove, and tie it with small twine. Fig. 16, represents a former for the cone. To make the caps, cut your paper in round pieces, equal in diameter to twice the length of the cone you intend to make; which pieces being cut into halves, will make two caps each, without wasting any paper; having formed the caps, paste over each of them a thin white paper, which must be a little longer than the cone, so as to project about half an inch below the bottom;
this

FIG. J



R. Jones del.

Darling fec.



this projection of paper, being notch'd and pasted, serves to fasten the cap to the head.

When you load the heads of your rockets with stars, rains, serpents, crackers, scroles, or any thing else, according to your fancy ; remember always to put one ladle-ful of meal powder, into each head, which will be enough to burst the head, and disperse the stars or whatever is contained therein : when the heads are loaded with any sort of cases, let their mouths be placed downwards ; and after the heads are filled, paste on the top of them a piece of paper, before you put on the caps. As the size of stars often differ, it would be needless to give an exact number for each rocket, but this rule may be observed, that the heads may be nearly filled with whatever they are loaded.

Of the Decorations for Sky Rockets.

Sky rockets bearing the pre-eminence of all fireworks, it will not be improper to treat of their various kinds of decoration, which are directed according to
fancy ;

fancy; some are headed with stars of different sorts, such as tailed stars, brilliant stars, white stars, blue and yellow stars, &c. some with gold and silver rain; others with serpents, crackers, fire-croles, marrons; and some with small rockets, and many other devices, as the maker pleases.

Dimensions and Poise of Rocket Sticks.

weight of the rocket	Length of the stick.		Thickness at top.	Breadth at top.	Square at bottom.	Poize from the point of the cone.	
lb. oz.	ft.	in.	Inches.	Inches.	Inch.	ft.	in.
6 0	14	0	1,5	1,85	0,75	4	1,5
4 0	12	10	1,25	1,40	0,625	3	9,
2 0	9	4	1,125	1,	0,525	2	9,
1 0	8	2	0,725	0,80	0,375	2	1,
8	6	6	0,5	0,70	0,25	1	10,5
4	5	3	0,3750	0,55	0,35	1	8,5
2	4	1	0,3	0,45	0,15	1	3,
1	3	6	0,25	0,35	0,10	11	0,
$\frac{1}{2}$	2	4	0,125	0,20	0,16	8	0,
$\frac{1}{4}$	1	10 $\frac{1}{2}$	0,1	0,15	0,5	5	0,5

The last column on the right in the above table, expresses the distance from the top of the cone, where the stick, when tied on, should ballance the rocket,

et, so as to stand in an equilibrium on one's finger or the edge of a knife. The best wood for the sticks is dry deal, made after the following manner; when you have cut and planed the sticks according to the dimensions given in the table, cut on one of the flat sides at top, a groove the length of the rocket, and as broad as the stick will allow; then on the opposite flat side, cut two notches for the cord, which ties on the rocket, to lay in; one of these notches must be near the top of the stick, and the other facing the neck of the rockets; the distance between these notches may easily be known, for the top of the stick should always touch the head of the rocket. When your rockets and sticks are ready, lay the rockets in the grooves in the sticks and tie them on. Those who, merely for curiosity, may chuse to make rockets of different sizes, to what I have expressed in the table of dimensions, may find the length of their sticks, by making them for rockets, from half an ounce to one pound, sixty diameters of the rocket long; and for rockets above one pound, fifty or fifty-two diameters will be a good length; their thickness at top
may

may be about half a diameter, and their breadth a very little more; their square at bottom is generally equal to half the thickness at top. But, although the dimensions of the sticks be very nicely observed, you must depend only on their ballance: for, without a proper counterpoise, your rockets, instead of mounting perpendicularly, will take an oblique direction, and fall to the ground before they are burnt out.

The Method of Boring Rockets which have been drove solid.

Plate 2, Fig. 18, represents the plan of an apparatus, or lath, for boring of rockets; A the large wheel which turns the small one B, that works the reamer C: these reammers are of different sizes according to the rockets; they must be of the same diameter as the top of the bore intended, and continue that thickness a little longer than the depth of the bore required, and their points must be like that of an auger; the thick end of each reammer must be made square and all of the same size, so as to fit into

one socket, wherein they are fastened by a screw D : E the guide for the reamer, which is made to move backwards and forwards ; so that after you have marked the reammer three diameters and a half of the rocket from the point, set the guide, allowing for the thickness of the fronts of the rocket boxes, and the neck and mouth of the rocket, so that when the front of the large box is close to the guide, the reammer may not go too far up the charge. F, boxes for holding the rockets, which are made so as to fit one in another ; their sides must be equal in thickness to the difference of the diameters of the rockets, and their interior diameters equal to the exterior diameters of the rockets. To prevent the rockets turning round while boring, a piece of wood must be placed against the end of the box in the inside, and pressed against the tail of the rocket ; this will also hinder the reammer from forcing the rocket backwards. G, a rocket in the box. H, a box that slides under the rocket boxes to receive the borings from the rockets, which falls through holes made on purpose in the boxes ; these holes must be just under

H the

the mouth of the rocket, one in each box, and all to correspond with each other.

Fig. 19, is a front view of the large rocket box. I, an iron plate, in which are holes of different sizes, through which the reammer passes; this plate is fastened with a screw in the center, so that when you change the reammer, you turn the plate round, but always let the hole you are going to use be at the bottom: the fronts of the other boxes must have holes in them to correspond with them in the plate. K, the lower part of the large box, which is made to fit the inside of the lathe, in order that all the boxes may move quite steady.

Fig. 20, is a perspective view of the lathe. L, the guide for the reammer, which is set by the screw at bottom.

Fig. 21, a view of the front of the guide facing the reammer. M, an iron plate, of the same dimensions as that on the front of the box, and placed in the same direction, and also to turn on a screw in the center. N, the rocket box, which slides backwards and forwards: when you have fixed a rocket in the box, push it forwards against the reammer;
and

and when you think the scoop of the reammer is full, draw the box back, and knock out the composition; this you must do till the rocket is bored, or it will be in danger of taking fire; and if you bore in a hurry, wet the end of the reammer now and then with oil to keep it cool.

Having bored a number of rockets, you must have taps of different sorts according to the rockets. These taps are a little longer than the bore, but when you use them, mark them three diameters and a half from the point, allowing for the thickness of the rocket's neck; then, holding the rocket in one hand, you tap it with the other. In order to explain these taps, I have represented one by Fig. 22. They are made in the same proportion as the fixed piercers, and are hollowed their whole length.

Of a Hand Machine used for boring of Rockets instead of a Lathe.

Those sort of machines answer very well, but not so expeditious as the lathe, nor are they so expensive to make; they

may be worked by one man ; but the lathe will require three. Fig. 23, represents the machine. O, the rocket boxes, which are to be fixed and not to slide as those in the lathe. P Q, are guides for the reammers, that are made to slide together, as the reammer moves forward : the reammers for these sort of machines must be made of a proper length, allowing for the thickness of the front of the boxes, and the length of the mouth and neck of the case : on the square end of these reammers, must be a round shoulder of iron, to turn against the outside of the guide Q, by which means the guides are forced forwards. R, the stock which turns the reammer, and while turning must be pressed towards the rocket, by the body of the man who works it ; all the reammers are to be made to fit one stock. This machine as well as the lathe is made by the scale in the same plate.

The

The Manner of making large Gerbes.

Fig. 24, represents a wooden former; 25, a gerbe compleat, with its foot or stand. The cases for gerbes are made very strong, on account of the strength of the composition; which, when fired, comes out with great velocity; therefore, to prevent their bursting, the paper should be pasted, and the cases made as thick at the top as at the bottom; they ought also to have very long necks, for this reason; first, that the particles of iron will have more time to be heated, by meeting with greater resistance in getting out, than with a short neck, which would be burnt too wide before the charge be consumed, and spoil the effect: Secondly, that with long necks the stars will be thrown to a great height, and will not fall before they are spent, or spread too much; but, when made to perfection, will rise and spread in such a manner as to form exactly a wheat-sheaf.

In the ramming of gerbes, there will be no need of a mould, the cases being sufficiently strong to support themselves; but you are to be careful, before you begin to ram, to have a piece of wood made to fit in the neck; for if this be not done, the composition will fall into the neck, and leave a vacancy in the case, which, as I said before, will cause the case to burst as soon as the fire arrives at the vacancy: you must likewise observe, that the first ladle of charge, or two, if you think proper, be of some weak composition. When the case is filled, take out the piece of wood, and fill the neck with some slow charge. Gerbes are generally made about six diameters long, from the bottom to the top of the neck; their bore must be one fifth narrower at top than at bottom. The neck S is one sixth diameter and three fourths long. T, a wooden foot or stand, on which the gerbe is fixed. This may be made with a choak or cylinder, four or five inches long, to fit the inside of the case, or with a hole in it to put in the gerbe; both these methods will answer the same. Gerbes produce a most brilliant fire, and are very
beautiful

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when a number of them are fixed in the front of a building, or a collection of fireworks.

N. B. Gerbes are made by their diameters, and their cases at bottom one fourth thick. The method of finding the interior diameter of a gerbe is thus: Supposing you would have the exterior diameter of the case, when made, to be five inches, then, by taking two fourths for the sides of the case, there will remain two inches and a half for the bore, which will be a very good size. These sort of gerbes ought to be rammed very hard.

Of small Gerbes or White Fountains.

Small gerbes may be made of four, eight ounces, or one pound cases, pasted and made very strong, of what length you please; but, before you fill them, drive in dry clay one diameter of their orifice high, and when you have filled a case, bore a vent through the center of the clay to the composition; the common proportion will do for the vent, which must be primed with a slow

H 4 charge.

charge. These sort of cases without the clay, may be filled with Chinese fire.

To make Paste-board and Paper Mortars.

Fig. 26, a former, and 27, an elm foot for the mortar; 28, a mortar complete; these mortars are best when made with paste-board; your paste-board must be well pasted before you begin; or, instead of paste, you may use glue. For a cohorn mortar, which is four inches two fifths diameter, roll the paste-board on the former one sixth of its diameter thick; and, when dry, cut one end smooth and even, then nail and glue it on the upper part of the foot; when done, cut off the paste-board at top, allowing for the length of the mortar two diameters and a half from the mouth of the powder chamber; then bind the mortar round with a strong cord wetted with glue. U, the bottom part of the foot, is one diameter two thirds broad, and one diameter high; and that part which goes into the mortar is two thirds of its diameter high. W, is a copper chamber

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chamber for powder, made in a conical form, and is one third of the diameter wide, and one and a half of its own diameter long; in the center of the bottom of this chamber, make a small hole a little way down the foot; this hole must be met by another of the same size made in the side of the foot, as is shewn in Fig. 28. If these holes are made true, and a copper pipe fitted into both, the mortar when loaded will prime itself, for the powder will naturally fall to the bottom of the first hole; then, by putting a bit of quick-match in the side hole, your mortar will be ready to be fired.

Mortars of five and a half, eight, and ten inches diameter, may be made of paper, or paste-board, by the above method, and in the same proportion; but if larger, it will be best to have them made of brass. N.B. The copper chamber, must have a small rim round its edge with holes in it, for screws to make it fast in the foot.

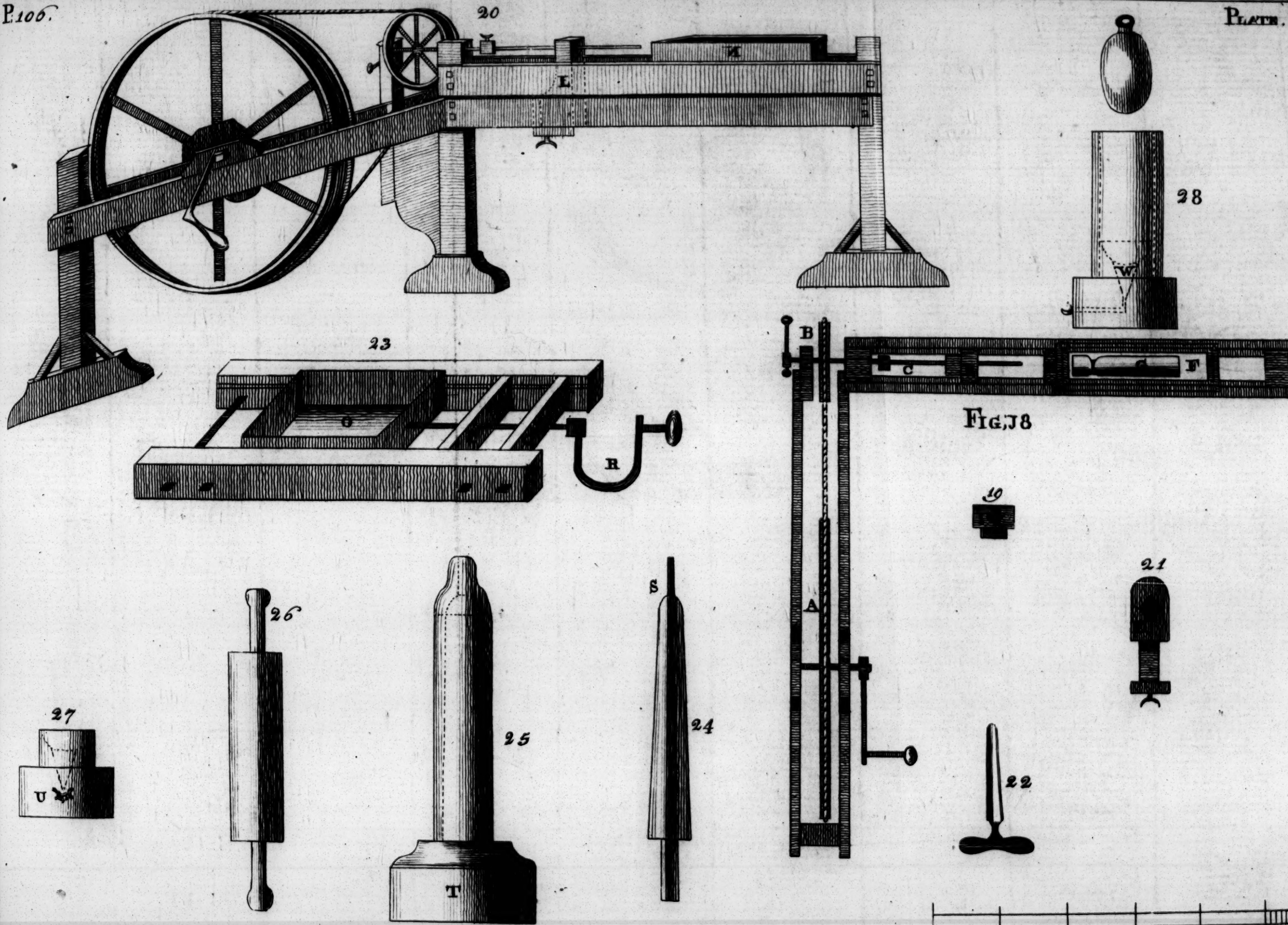
S E C T.

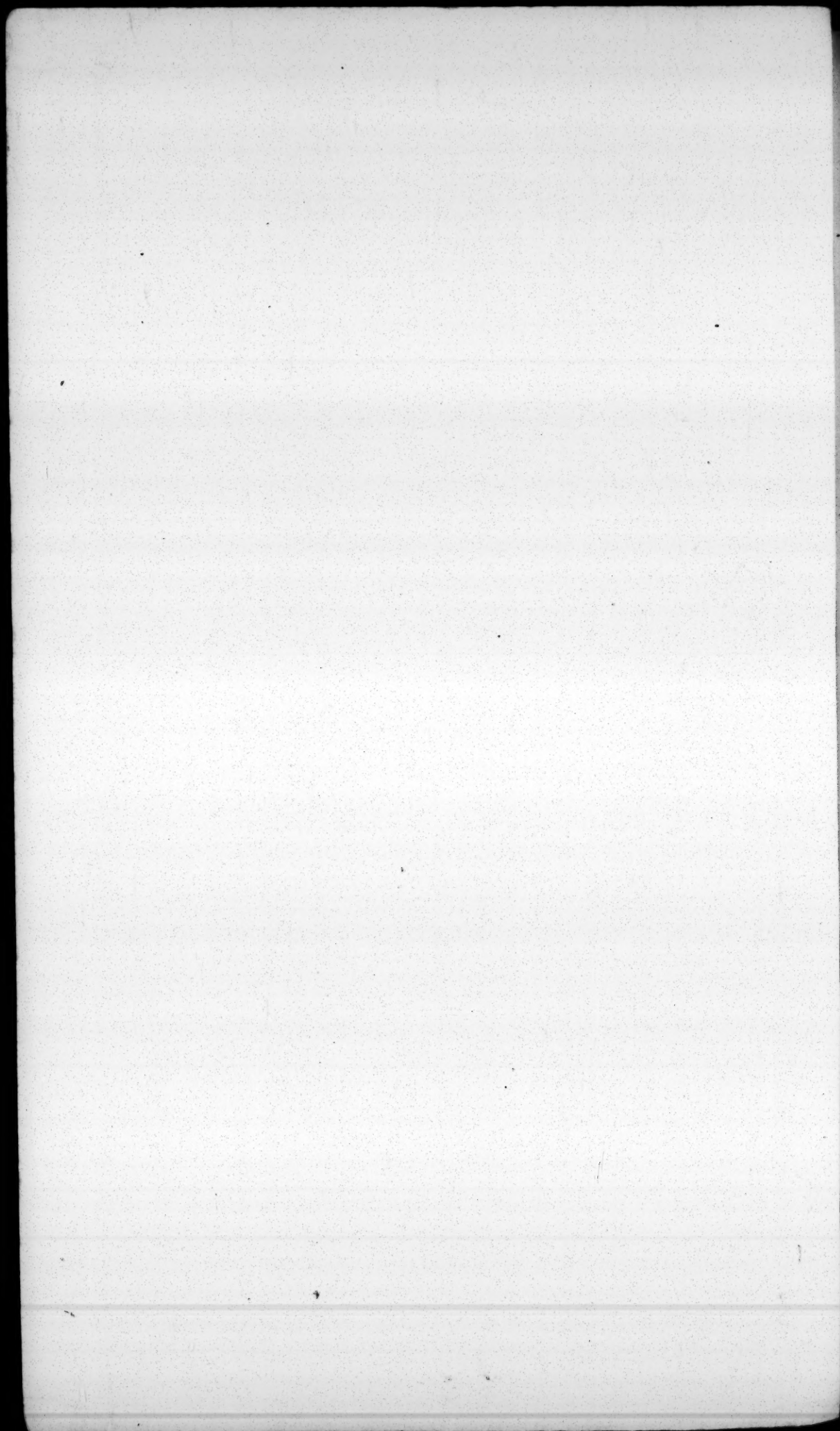
S E C T. IV.

The Manner of loading Air Ballóons, with the Number of Stars, Serpents, Snakes, Rain-falls, &c. contained in Shells of each Nature.

AS ballóons are held in great esteem, by most admirers of fire works, I shall here give a full description of them in every particular, in so clear a manner, that a young practitioner may, by taking a little pains, be pretty certain of succeeding the first trial.

When you fill your shells, you must first put in the serpents, rains, stars, &c. or whatever they are composed of; then the blowing powder; but the shells must not be quite filled; all those things must be put in at the fuze hole; but marrons,
being





being too large to go in at the fuze hole, must be put in before the inside shell be joined. When the shells are loaded, glue and drive in the fuzes very tight. Of these fuzes we shall say more hereafter; but shall here give the diameter of the fuze hole in ballóons of each nature, which are as follows. For a coe-horn ballóon, let the diameter of the fuze hole be seven eighths of an inch. For a royal ballóon, which is near five inches and a half diameter, make the fuze hole one inch one eighth diameter. For an eight inch ballóon, one inch three eighths: and for a ten inch ballóon, one inch five eighths.

Having proceeded thus far with the directions of loading ballóons, I shall in the second place give an account of the quantities and number of each article, proper for shells of each nature; but it is to be observed, that air-ballóons are divided into four sorts, viz. first, illuminated ballóons; second, ballóons of serpents; third, ballóons of reports, marrons, and crackers; and fourth, compound ballóons.

For

For a Coehorn Ballóón illuminated.

			OZ.
Meal powder	—	—	$1\frac{1}{2}$
Corn powder	—	—	$0\frac{1}{2}$
Powder for the mortar	—		2

Length of the fuze composition three quarters of an inch; one ounce drove or rolled stars, as many as will nearly fill the shell.

For a Coehorn Ballóón of Serpents.

			OZ.
Meal powder	—	—	$1\frac{1}{4}$
Corn powder	—	—	1
Powder for the mortar	—		$2\frac{1}{4}$

Length of the fuze composition thirteen sixteenths of an inch; half ounce cafes drove three diameters and bounced three diameters; and half ounce cafes drove two diameters and bounced four; of each an equal quantity, and as many of them as will fit in casily, placed head to tail.

For

For a Coehorn Ballóon of Crackers and Reports.

			oz.
Meal powder	—	—	$1\frac{1}{4}$
Corn powder	—	—	$0\frac{3}{4}$
Powder for the mortar	—	—	2

Length of the fuze composition three quarters of an inch; reports four, and crackers of six bounces, as many as will fill the shell.

For Compound Coehorn Ballóons.

			oz.	dr.
Meal powder	—	—	1	4
Corn powder	—	—	0	12
Powder for the mortar	—	—	2	4

Length of the fuze composition thirteen sixteenths of an inch; half ounce cafes drove three diameters and a half and bounced two, sixteen. Half ounce cafes drove four diameters and not bounced, ten. Blue strung stars, ten. Rolled stars as many as will compleat the ballóon.

For

For Royal Ballóons illuminated.

			oz.	dr.
Meal powder	—	—	1	8
Corn powder	—	—	0	12
Powder for the mortar		—	3	0

Length of the fuze composition fifteen sixteenths of an inch ; two ounce strung stars, thirty-four : Rolled stars as many as the shell will contain, allowing room for the fuze.

For Royal Ballóons of Serpents.

			oz.	dr.
Meal powder	—	—	1	0
Corn powder	—	—	1	8
Powder for the mortar		—	3	8

Length of the fuze composition one inch ; one ounce cases drove three and a half and four diameters, and bounced two, of each an equal quantity, sufficient to load the shell.

Royal

Royal Ballóons of Crackers and Marrons.

		oz.	dr.
Meal powder	—	1	8
Corn powder	—	1	4
Powder for firing the mortar		3	0

Length of the fuze composition fourteen sixteenths of an inch; reports twelve, and compleated with crackers of eight bounces.

For Compound Royal Ballóons.

		oz.	dr.
Meal powder	—	1	5
Corn powder	—	1	6
Powder for the mortar	—	3	12

Length of the fuze composition one inch; half ounce cafes drove and bounced two diameters, eight. Two ounce cafes filled three eighths of an inch with star composition, and bounced two diameters, eight. Silver rain-falls, ten. Two ounce tailed stars, sixteen. Rolled brilliant stars,

stars, thirty. If this should not be sufficient to load the shell, you may compleat it with gold rain falls.

For eight inch Ballóóns illuminated.

		oz.	dr.
Meal powder	_____	2	8
Corn powder	_____	1	4
Powder for the mortar	_____	9	0

Length of the fuze composition one inch one eighth ; two ounce drove stars, forty-eight. Four ounce cases drove with star composition three eighths of an inch and bounced three diameters, twelve ; and the ballóón compleated with two ounce drove brilliant stars.

For eight inch Ballóóns of Serpents.

		oz.	dr.
Meal powder	_____	2	0
Corn powder	_____	2	0
Powder for the mortar	_____	9	8

Length

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Length of the fuze composition one inch three sixteenths. Two ounce cases drove one diameter and a half, and bounced two; and one ounce cases drove two diameters, and bounced two and a half; of each an equal quantity sufficient for the shell.

N. B. The star composition which is drove in cases that are bounced, must be managed thus; first the cases must be pinched close at one end, then the corn powder put in for a report, and the case pinched again close to the powder, only leaving a small vent for the star composition, which is drove at top, to communicate to the powder at the bounce end.

R E M A R K S.

Ballóons filled with crackers, reports, and marrons, make no great show of themselves, nor are they very pleasing to the eye, for they represent nothing more than a number of pale white flashes, followed by a variety of reports; which altogether make but a very indifferent appearance when fired with illuminated ballóons, which are so beautiful and
I brilliant,

brilliant, as to cast forth such lustre that will dazzle the eyes of the spectators for some time; on this consideration, I do not think it worth while loading shells of a large nature, with things that afford so little pleasure: but they have a pretty good effect in royal shells, when thrown among a number of air works, such as pots des brins or flights of rockets, in order to alarm the people with a thundering in the air. For they will not know from whence the reports came, if fired exactly at the same time with the other works, and the fuze made to carry a small fire. But if any one thinks proper to make large ballóons of this sort, it is only observing a proportion of the blowing and firing powder, and the length of the fuze, for shells of the same dimensions as those you intend to make. These kind of ballóons are lighter than any other sort, by reason of the crackers being light of themselves, and not lying close in the shells. It must be observed, when you fire light ballóons, not to put so much powder in the mortar as for heavy ones.

Compound

Compound Eight-inch Ballóóns.

		oz.	dr.
Meal powder	—	2	8
Corn powder	—	1	12
Powder for the mortar	—	9	4

Length of the fuze composition one ^{inch one} eighth; four ounce cafes drove with star composition three eighths of an inch, and bounced three diameters, sixteen. Two ounce tailed stars, sixteen. Two ounce drove brilliant stars, twelve. Silver rain-falls, twenty. One ounce drove blue stars, twenty: and one ounce cafes drove and bounced two diameters, as many as will fill the shell.

Another of Eight-inches:

		oz.	dr.
Meal powder	—	2	8
Corn powder	—	1	12
Powder for the mortar	—	9	4

Length of the fuze composition one inch one eighth; crackers of six reports, ten. Gold rains, fourteen. Two ounce
 I 2 cafes

cafes drove with star composition three eighths of an inch, and bounced two diameters, sixteen. Two ounce tailed stars, sixteen. Two ounce drove brilliant stars, twelve. Silver rains, ten : one ounce drove blue stars, twenty : and one ounce cafes drove with a brilliant charge two diameters and bounced three, as many as the shell will hold.

Another of Eight-inches.

			oz.	dr.
Meal powder	—	—	2	12
Corn powder	—	—	2	0
Powder for the mortar	—		9	0

Length of the fuze composition one inch one sixteenth ; crackers of six reports, ten. Gold rains, twenty. Two ounce cafes drove with star composition half an inch, and bounced two diameters sixteen. Two ounce drove brilliant stars, two ounce drove blue stars, two ounce drove coloured stars, two ounce drove tailed stars, large strung stars, and rolled stars, of each an equal quantity, sufficient for the ballóon.

For

For a compound Ten-inch Ballóón.

			oz.	dr.
Meal powder	—	—	3	4
Corn powder	—	—	2	8
Powder for the mortar		—	12	8

Length of the fuze composition fifteen sixteenths of an inch; one ounce cafes drove and bounced three diameters, sixteen. Crackers of eight reports, twelve. Four ounce cafes drove half an inch with star composition, and bounced two diameters, fourteen. Two ounce cafes drove with brilliant fire one diameter and a quarter, and bounced two diameters, sixteen. Two ounce drove brilliant stars, thirty. Two ounce drove blue stars, thirty. Gold rains, twenty. Silver rains, twenty: after all these are put in, fill the remainder of the cafe with tailed and rolled stars.

For a Ten-inch Ballóón of three Changes.

		oz.	dr.
Meal powder	————	3	0
Corn powder	————	3	2
Powder for the mortar	————	13	0

Length of the fuze composition one inch; the shell must be loaded with two ounce cafes, drove with star composition a quarter of an inch, and on that one diameter of gold fire, then bounced three diameters; or with two ounce cafes first filled one diameter with gold-fire, then a quarter of an inch with star composition, and on that one diameter and a quarter of brilliant fire. These cafes must be well secured at top of the charge, lest they should take fire at both ends, but their necks must be larger than the common proportion.

To make Ballóón Fuzes.

Fuzes for air ballóóns are sometimes turned out of dry beech, with a cup at top.

top, to hold the quick-match, as you see in Plate II. Fig. 28, but if made with pasted paper, they will do as well : the diameter of the former for fuzes for coehorn ballóons, must be half an inch ; for a royal fuze, five eighths of an inch ; for an eight inch fuze, three quarters of an inch ; and for a ten inch fuze, seven eighths of an inch. Having rolled your cases, pinch and tie them almost close at one end ; then drive them down, and let them dry ; before you begin to fill them, mark, on the outside of the case, the length of charge required, allowing for the thickness of the bottom ; and when you have rammed in the composition, take two pieces of quick-match, about six inches long, and lay one end of each on the charge, and then a little meal powder, which ram down hard ; the loose ends of the match double up into the top of the fuze, and cover it with a paper cap to keep it dry. When you put the shells in the mortars, uncap the fuzes, and pull out the loose ends of the match, and let them hang on the sides of the ballóons ; the use of the match is, to receive the fire from the powder in

the chamber of the mortar, in order to light the fuze: the shell being put in the mortar with the fuze uppermost, and exactly in the center; sprinkle over it a little meal-powder, and it will be ready to be fired. Fuzes made of wood must be longer than those of paper, and not bored quite through, but left solid about half an inch at bottom; and when you use them, saw them off to a proper length, measuring the charge from the cup at top.

Of Tourbillons.

Having filled some cases within about one diameter and a half, drive in a ladle full of clay, then pinch their ends close, and drive them down with a mallet; when done, find the center of gravity of each case, where you nail and tie a stick which should be half an inch broad at the middle, and run a little narrower to the ends these sticks must have their ends turned upwards, so that the cases may turn horizontally on their centers: at the opposite sides of the cases at each end, bore a hole close to the clay with a gimblet,

a gimblet, the size of the neck of a common case of the same nature; from these holes draw a line round the case, and at the under part of the case bore a hole, with the same gimblet, within half a diameter of each line towards the center; then from one hole to the other draw a right line. This line divide into three equal parts, and at X and Y, Fig. 29, Plate III. bore a hole, then from these holes to the other two, lead a quick-match, over which paste a thin paper. Fig. 30, represents a tourbillon as it should lay to be fired, with a leader from one side hole A, to the other B. When you fire tourbillons, lay them on a smooth table, with their sticks downwards, and burn the leader thro' the middle with a port fire. They should spin three or four seconds on the table before they rise, which is about the time the composition will be burning, from the side holes to those at bottom.

To tourbillons may be fixed reports, in this manner; in the center of the case at top, make a small hole, and in the middle of the report make another; then place them together, and tie on the report, and with a single paper secure

cure it from fire, this being done your tourbillon is compleated. By this method you may fix on tourbillons, small cones of stars, rains, &c. but be careful not to load them too much. One eighth of an inch will be enough for the thickness of the sticks, and their length equal to that of the cases.

The Manner of making Mortars,
for throwing Aigrettes and loading
and firing the same.

Mortars used for throwing aigrettes are generally made of paste-board, of the same thickness as ballóon mortars, and two diameters and a half long in the inside from the top of the foot; the foot must be made of elm without a chamber, but flat at top, and in the same proportion as those for ballóon mortars; these sort of mortars must also be bound round with cord as before mentioned; sometimes eight or nine of these sort of mortars, of about three or four inches diameter, are bound all together so as to appear but one; but when they are made for this purpose, the bottom of
the

the foot must be of the same diameter as the mortars ; and only half a diameter high. Your mortars being bound well together, fix them on a heavy solid block of wood : to load these mortars, first put on the inside bottom of each, a piece of paper, and on it spread one ounce and a half of meal and corn powder mixed ; then tie your serpents up in parcels with quick-match, and put them in the mortar with their mouths downwards ; but take care that the parcels do not fit too tight in the mortars, and that all the serpents have been well primed with powder, wetted with spirit of wine ; on the top of the serpents in each mortar lay some paper or tow ; then carry a leader from one mortar to the other all round, and then from all the outside mortars into that in the middle ; these leaders must be put between the cases, and the sides of the mortar down to the powder at bottom : in the center of the middle mortar, fix a fire-pump or brilliant fountain, which must be open at bottom, and long enough to project out of the mouth of the mortar ; then paste paper on the tops of all the mortars.

Mortars

Mortars thus prepared are called a nest of serpents, as represented by Fig. 31. When you would fire these mortars, light the fire-pump C, which when consumed will communicate to all the mortars at once, by means of the leaders. For mortars of six, eight, or ten inches diameter, the serpents should be made in one and two ounce cases, six or seven inches long, and fired by a leader, brought out of the mouth of the mortar, and turned down the outside, and the end of it covered with paper, to prevent the sparks of the other works from setting it on fire. For a six inch mortar, let the quantity of powder for firing be two ounces; for an eight inch, two ounces and three quarters; and for a ten inch, three ounces and three quarters; care must be taken in these as well as small mortars, not to put the serpents in too tight, for fear of bursting the mortars. These sort of mortars may be loaded with stars, crackers, &c.

If the mortars, when loaded, are to be sent any distance, or liable to be much moved, the firing powder should be secured from getting amongst the serpents, which would endanger the mortars, as well

well as hurt their performance ; to prevent which, load your mortars after this manner ; first put in the firing powder and spread it equally about ; then cut a round piece of blue touch-paper, equal to the exterior diameter of the mortar, and draw on it a circle, equal to the interior diameter of the mortar, and notch it all round as far as that circle ; then paste that part which is notched, and put it down the mortar close to the powder, and stick the pasted edge to the mortar ; this will keep the powder always smooth at bottom, so that it may be moved or carried any where, without receiving any damage. The large single mortars are called pots des aigrettes.

The Manner of making, loading, and firing of Pots des Brins.

These pots are made of paste-board, and must be rolled pretty thick ; they are usually made three or four inches diameter, and four diameters long, and pinched with a neck at one end, like common cases ; a number of these are
placed

placed on a plank in the following manner : having fixed on a plank, two rows of wooden pegs, cut, in the bottom of the plank, a groove the whole length under each row of pegs ; then, through the centre of each peg, bore a hole down to the groove at bottom, and on every peg fix and glue a pot, whose mouth must fit tight on the peg ; thro' all the holes run a quick-match, one end of which must go into the pot, and the other into the groove, which must have a match laid in it from end to end, and covered with paper, so that when lighted at one end, it may discharge the whole almost instantaneously : in all the pots put about one ounce of meal and corn powder ; then in some put stars, and others rains, snakes, serpents, crackers, &c. when they are all loaded, paste paper over their mouths. Two or three hundred of these pots being fired together, make a very pretty show, by affording so great a variety of fires. Fig. 32, is a range of pots des brins, with the leader A, by which they are fired.

Of

Of Pots des Saucissons.

Saucissons are generally fired out of large mortars without chambers, the same as those for aigrettes, only somewhat stronger: saucissons are made of one and two ounce cases, five or six inches long, and choaked in the same manner as serpents; half the number which the mortar contains, must be drove one diameter and a half with composition, and the other half two diameters, so that when fired they may give two volleys of reports; but if the mortars be very strong, and will bear a sufficient charge, to throw the saucissons very high, you may make three volleys of reports, by dividing the number of cases into three parts, and making a difference in the height of the charge: after they are filled, pinch and tie them at top of the charge, almost close; only leaving a small vent to communicate the fire to the upper part of the case, which must be filled with corn powder very near the top; then pinch the end quite close, and tie it; after this is done, bind the case very tight with waxed pack-thread,

thread, from the choak at top of the composition, to the end of the case; this will make the case very strong in that part, and cause the report to be very loud: faucifrons should be rolled a little thicker of paper than the common proportion. When they are to be put in the mortar, they must be primed in their mouths, and fired by a case of brilliant fire, fixed in their center.

The charge for these sort of mortars should be one sixth, or one eighth, more than for pots des aigrettes of the same diameter.

To fix one Rocket on the Top of another.

When sky rockets are thus managed, they are called towering rockets, on account of their mounting so very high. Towering rockets are made after this manner; fix on a pound rocket a head without a collar; then take a four ounce rocket, which may be headed or bounced, and rub the mouth of it with meal powder wetted with spirit of wine, when done put it in the head of the large rocket
with

with its mouth downwards; but before you put it in, stick a bit quick-match in the hole in the clay of the pound rocket, which match should be long enough to go a little way up the bore of the small rocket, in order to fire it, when the large one is burnt out; the four ounce rocket being too small to fill the head of the other, roll round it as much tow as will make it stand upright in the center of the head: the rocket being thus fixed, paste a single paper round the opening of the top of the head of the large rocket. The large rocket must have only half a diameter of charge rammed above the piercer, for if filled to the usual height, it would turn before the small one takes fire, and entirely destroy the intended effect; when one rocket is headed with another, there will be no occasion for any blowing powder; for the force with which it sets off, will be sufficient to disengage it from the head of the first fired rocket. The sticks for these sort of rockets, must be a little longer than for those headed with stars, rains, &c.

Of Caduceus Rockets.

Caduceus rockets in rising form two spiral lines, or double worm, by reason of their being placed obliquely, one opposite the other ; and their counterpoise in their center, which causes them to rise in a vertical direction. Rockets for this purpose, must have their ends choaked close, without either head or bounce ; for a weight at top, would be a great obstruction to their mounting ; though I have known them sometimes to be bounced, but then they did not rise so high as those that were not, nor do any Caduceous rockets ascend so high as single ones ; because of their serpentine motion, and likewise the resistance of air, which is much greater than two rockets of the same size would meet with, if fired singly.

By Fig. 33. you see the method of fixing these rockets : the sticks for this purpose, must have all their sides equal, which sides should be equal to the breadth of a stick, proper for a sky rocket of the same weight as those you intend to use, and to taper downwards

as

as usual, long enough to ballance them, one length of a rocket, from the cross stick; which must be placed from the large stick, six diameters of one of the rockets, and its length seven diameters so that each rocket when tied on, may form with the large stick an angle of sixty degrees. In tying on the rockets, place their heads on the opposite sides of the cross stick; and their ends on the opposite sides of the long stick, then carry a leader from the mouth of one, into that of the other. When these rockets are to be fired, suspend them between two hooks or nails, then burn the leader through the middle, and both will take fire at the same time. Rockets of one pound, are a good size, for this use.

Of Honorary Rockets.

Honorary rockets are the same as sky rockets, except that they carry no head nor report, but are closed at top, on which is fixed a cone, then on the case, close to the top of the stick, you tie a two ounce case, about five or six inches long, filled with a strong charge, and pinched close at both ends; then in the

reverse sides at each end, bore a hole, in the same manner as in Tourbillons; from each hole, carry a leader, into the top of the rocket. When the rocket is fired, and arrived to its proper height, it will give fire to the case at top, which will cause both rocket and stick, to spin very fast, in their return, and represent a worm of fire, descending to the ground.

There is another method of placing the small case, which is by letting the stick rise a little above the top of the rocket, and tying the case to it, so as to rest on the rocket: these sort of rockets have no cones.

There is also a third method, by which these kind of rockets are managed, which is thus: In the top of the rocket fix a piece of wood, in which drive a small iron spindle, then make a hole in the middle of the small case, through which put the spindle; then fix on the top of it a nut, to keep the case from falling off; when this is done, the case will turn very fast, without the rocket: but this method does not answer so well, as either of the former.

Fig.

Fsg. 34. is a honorary rocket complete. The best sized rockets for this purpose are those of one pound.

To divide the Tail of a Sky
Rocket, so as to form an Arch
when ascending.

Having some rockets made, and headed according to fancy, and tied on their sticks; get some sheet tin, and cut it into round pieces, about three or four inches diameter, then on the stick of each rocket, under the mouth of the case, fix one of these pieces of tin; sixteen inches from the rockets neck, and support it by a wooden bracket, as strong as possible: the use of this, is, that when the rocket is ascending, the fire will play with great force on the tin, which will divide the tail in such a manner, that it will form an arch, as it mounts, (and will have a very good effect if well managed) if there be a short piece of port-fire, of a strong charge, tied to the end of the stick, it will make a great addition; but this must be lighted, before you fire the rocket.

To make several Sky Rockets, rise together, in the same direction, and equally distant from each other.

Take six or any number of sky rockets, of what size you please; then cut some strong pack-thread, into pieces of three or four yards long, and tie each end of these pieces to a rocket in this manner. Having tied one end of your pack-thread, round the body, of one rocket, and the other end to another; take a second piece of pack-thread and make one end of it fast to one of the rockets already tied, and the other end to a third rocket, so that all the rockets except the two outside ones will be fastened to two pieces of pack-thread; the length of thread, from one rocket to the other, may be what the maker pleases; but the rockets must be all of a size, and their heads filled with the same weight of stars, rains, &c.

Having thus done, fix in the mouth of each rocket, a leader of the same length; and, when you are going to
fire

fire them, hang them almost close together, then tie the ends of the leaders together, and prime them ; this prime being fired, all the rockets will mount at the same time, and divide themselves as far as the strings will allow ; which division they will keep, provided they are all rammed alike, and well made. These sort of rockets, are called by some, chained-rockets.

Of Signal Sky Rockets.

Signal-rockets are made of several sorts, according to the different signals intended to be given : but in Artificial Fireworks, two sorts are only made use of, which are one with reports, and the other without any thing, except the charge ; but those for the use of the Navy and Army, are headed with stars, serpents, &c. ——— Rockets which are to be bounced, must have their cases made one and a half or two diameters longer, than the common proportion, and after they are filled, drive in a double quantity of clay, then bounce and pinch them, after the usual manner, and fix on each a cap.

Signal sky rockets without bounces, are nothing more than common sky rockets, closed and caped : rockets of this sort are very light, therefore do not require such heavy sticks as those with loaded heads, for which reason, you may cut one length of the rocket, off the stick, or else make them thinner.

Signal rockets with reports, are sometimes fired in small flights, and often both these and those without reports, are used, for a signal, to begin firing a collection of works; and occasionally, for many other purposes.

How to fix two or more Sky Rockets on one stick.

Two, three, or six sky rockets, fixed on one stick, and fired together, make a grand and beautiful appearance; for the tails of all will seem but as one of an immense size, and the breaking of so many heads at once, will resemble the bursting of an air ballóon; but the management of this device, requires a skilful hand; therefore for the encouragement of those who are fond of curious performances, I shall give such instructions,

structions, that, if well observed, even by those who have not made a great progress in this art, there will be no doubt, of the rockets having the desired effect.

Rockets for this purpose, must be made with the greatest exactness, all rammed by the same hand, in the same mould, and out of the one proportion of composition; and after they are filled and headed, must all be of the same weight; the stick must also be well made, (and proportioned) according to the following directions: first supposing your rockets to be half pounders, whose sticks are six feet six inches long, then if two, three, or six of these are to be fixed on one stick, let the length of it, be nine feet nine inches, then cut the top of it, into as many sides, as there are rockets, and let the length of each side be equal to the length of one of the rockets without its head; and in each side, cut a groove (as usual,) then from the grooves, plane it round, down to the bottom, where its thickness must be equal to half the top of the round part. As the thickness of these sort of sticks, cannot be exactly ascertained, I shall give a rule which generally answers, for any number of rockets above two:
the

the rule is this; that the stick at top, must be thick enough when the grooves are cut, for all the rockets to lay, without pressing each other, though as near together as possible.

When only two rockets, are to be fixed on one stick, let the length of the stick be according to the last given proportion, but shaped after the common method, and the breadth and thickness, double the dimensions, given in the table page, 94. The point of poise, must be in the usual place, (let the number of rockets be what they will:) if sticks made by the above directions, should be too heavy, plane them thinner; and if too light, make them thicker; but always make them of the same length.

When more than two rockets, are tied on one stick, there will be some danger, of their flying up without the stick, unless the following precaution be taken, for cases being placed on all sides, there can be no notches, for the cord which ties on the rockets, to lay in; therefore instead of notches, drive a small nail, in each side of the stick, between the necks of the cases; and let the cord which goes round their necks, be brought

brought close under the nails; by this means, the rockets will be as secure, as when tied on singly. Your rockets being thus fixed, carry a quick-match without a pipe, from the mouth of one rocket to the other; this match being lighted will give fire to all the rockets at once.

Notwithstanding the directions already given, may be sufficient, for the management of those sort of rockets; I shall here add an improvment, of my own, on a very essential part of this device, which is, that of hanging the rockets, to be fired; for before I hit upon the following method, many of my essays, proved unsuccessful; but to prevent such perplexities, instead of the old and common manner of hanging them on nails or hooks, make use of this contrivance, have a ring made of strong iron wire, large enough for the stick to go in, as far as the mouths of the rockets, then let this ring be supported by a small iron, at some distance, from the post or stand, to which it is fixed; then have another ring, fit to receive and guide the small end of the stick; rockets thus suspended will have nothing to obstruct their fire; but when they are
hung

hung on nails or hooks, in such a manner, that some of their mouths, are against or upon a rail, there can be no certainty of their rising, in a vertical direction.

Of Sky Rockets without sticks.

To fire rockets without sticks, you must have a stand made in this manner; get a block of wood, one foot diameter or thereabouts, and make the bottom of it flat, so that it may stand steady; in the center of the top of this block, draw a circle two inches and a half diameter, and divide the circumference of it into three equal parts; then take three pieces of thick iron wire, each about three feet in length, and drive them into the block, one at each point made on the circle; when these wires, are drove in, deep enough to hold them fast, and upright, so that the distance from one to the other, be the same at top, as at bottom, the stand is compleat.

The stand being thus made, prepare your rockets after the following method; take some common sky rockets, of any size, and head them as you please, then
get

get some balls of lead, and tie to each a small wire, two, or two feet and a half long, and the other end of each wire, tie to the neck of a rocket; these balls answer the purpose of sticks, when made of a proper weight, which is about two thirds the weight of the rocket; but when they are of a proper size, they will ballance the rocket in the same manner as a stick, at the usual point of poize. To fire these sort of rockets, hang them, one at a time, between the tops of the wires, letting their heads rest on the points of the wires, and the balls hang down between them; if the wires should be too wide, for the rockets, press them together, till they fit, and if too close, force them open: the wires for this purpose, must be softened, so as not to have any spring, or they will not keep their position, when pressed close or opened.

Of Rain-falls for Sky Rockets, Double and Single.

Gold and silver rain composition, are drove in cases, that are pinched quite close at one end; if you roll them dry,
four

four or five rounds of paper will be strong enough, but if the are pasted, three rounds will do, and the thin sort of cartridge paper is best for those small cases; which in rolling you must not turn down the inside edge, as in other cases, for a double edge would be too thick for so small a bore; the moulds for rain falls, should be made of brass, and turned very smooth in the inside; or the cases, which are so very thin, would tear in coming out, for the charge must be drove in tight; and the better the case fits the mould, the more driving it will bare. These moulds have no nipple, but instead of which they are made flat; as it would be very tedious and troublesome, to shake the composition out of such small ladles, as are used for these cases; it will be necessary to have a funnel made of thin tin, to fit on the top of the case, by the help of which you may fill them very fast; for single rain falls for four ounce rockets, let the diameter of the former be two sixteenths of an inch, and the length of the case two inches; for eight ounce rockets, four sixteenths, and two diameters of the rocket long; for one pound rocket five sixteenths, and two diameters of the
rocket

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rocket long; for two pound rockets, five sixteenths, and three inches a half long; for four pound rockets, six sixteenths, and four inches and a half long; and for six pounders, seven sixteenths diameter, and five inches long.

Of double rain falls, there are two sorts; as for example, some appear first like a star, and then as rain; and some appear first as rain and then like a star: when you would have stars first; you must fill the cases within half an inch of the top, with rain composition, and the remainder with star composition; but when you intend the rain should be first, drive the case half an inch with star composition, and the rest with rain. By this method, may be made many changes of fire; for in large rockets, you may make them first burn as stars, then rain, and then again as stars, or they may first shew rain, then stars, and afterwards finish with a report, but when they are thus managed, cut open the first rammed end, after they are filled and bounced, at which place prime them; the star composition for this purpose must be a little stronger than for rolled stars.

Of

Of Strung Stars.

First take some thin paper, and cut it into pieces of an inch and a half square, or therabouts, then on each piece lay as much dry star composition as you think the paper will easily contain; then twist up the paper as tight as you can; when done, rub some past on your hands, and roll the stars between them, then set them to dry; your stars being thus made, get some flax or fine tow, and roll a little of it over each star, then paste your hands and roll the stars as before, and set them again to dry; when they are quite dry, with a piercer, make a hole through the middle of each, into which run a cotton quick-match, long enough to hold, ten or twelve stars, at three or four inches from one another: but any number of stars may be strung together by joining the match.

Of Tailed Stars.

Those sort of stars are called tailed stars, because there are a great number of sparks issue from them, which represent

present a tail like that of a comet; of those stars there are two sorts, which are rolled, and drove; when they are rolled they must be moistened, with a liquor made of half a pint of spirit of wine, and half a gil of thin size, of this as much as will wet the composition enough, to make it roll easy; when they are rolled, sift meal powder over them, and set them to dry.

When tailed stars are drove, the composition must be moistened with spirit of wine only, and not made so wet as for rolling; one and two ounce cases rolled dry, are best for this purpose; and when they are filled, unroll the case within three or four rounds of the charge, and all that you unroll cut off, then paste down the loose edge; two or three days after the cases are filled, cut them in pieces five or six eighths of an inch in length, then melt some wax, and dip one end of each piece into it, so as to cover the composition; the other end must be rubbed with meal powder wetted with spirit of wine.

Of Drove Stars.

Cases for drove stars, are rolled with paste, but are made very thin of paper; before you begin to fill them, damp the composition, with spirit of wine that has had some camphor dissolved in it; you may ram them indifferently hard, so that you do not break, or sack the case, and to prevent which they should fit tight in the mould: they are drove in cases of several sizes, from eight drams to four ounces; when they are filled in half ounce cases, cut them in pieces, of three quarters of an inch in length; if one ounce cases, cut them in pieces of one inch; if two ounce cases, cut them in pieces of one inch and a quarter in length, and if four ounce cases, cut them in pieces one inch and a half in length; having cut your stars of a proper size, prime them at both ends, with wet meal powder; stars of this sort are seldom put in rockets, they being chiefly intended for air ballóons, and drove in cases, to prevent the composition from being broke by the force of the blowing powder in the shell.

Of

Of Rolled Stars.

Rolled stars are commonly made about the size of a musket ball, though they are rolled of several sizes, from the bigness of a pistol ball, to one inch diameter; and sometimes they are made very small, but then they are called sparks; great care must be taken in making of stars, first, that the several ingredients be reduced to a fine powder; secondly, that the composition be well worked and mixed together. Before you begin to roll, take about a pound of composition, and wet it with the following liquid, enough to make it stick together and roll easy; spirit of wine, one quart, in which dissolve a quarter of an ounce of isinglass; if a great quantity of composition be wetted at once, the spirit, will evaporate, and leave it dry, before you can roll it into stars; having rolled up one proportion, shake the stars in meal powder, and set them to dry, which they will do in three or four days. But if you should want them for immediate use, dry them in an earthen pan over a slow heat, or, in an oven: it being

very difficult to make the stars all of an equal size, when the composition is taken up promiscuously with the fingers; therefore I shall here set down a method by which you may make them very exact, which is thus: When the mixture is moistened properly, roll it on a flat smooth stone, and cut it into square pieces, making each square, large enough for the stars you intend; there is another method used by some to make stars, which is by rolling the composition, in long pieces, and then cutting off the star, so that each star will be of a cylindrical form; but this method is not so good as the former, for to make the composition roll this way, it must be made very wet, which makes the stars heavy as well as weaken them. All stars must be kept as much from air, as possible, otherwise they will grow weak and bad.

Of Scrolls for Sky Rockets.

Cases for scrolls, should be made four or five inches in length, and their interior diameter three eighths of an inch; one end of these cases must be pinched quite

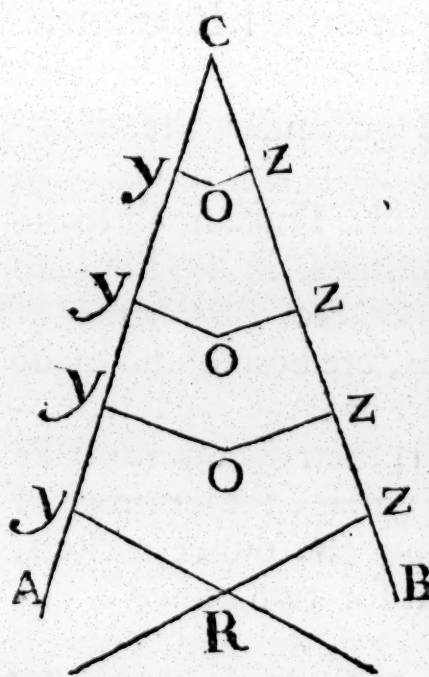
quite close, before you begin to fill, and and when filled, close the other end, then in the opposite sides make a small hole at each end, to the composition, in the same manner as in Tourbillons; and prime them with wet meal powder: you may put in the head of a rocket, as many of these cases as it will contain; these cases being fired turn very quick in the air, and form a scroll or spiral line. They are generally filled with a strong charge, as that of serpents, or brilliant fire.

Of Swarmers or small Rockets.

Rockets which go under the denomination of swarmers, are those from two ounces downwards. These small rockets are fired sometimes, in flights, and in large water-works, &c. Swarmers of one and two ounces, are bored, and made in the same manner as large rockets, except when headed, their heads must be put on without a collar; the number of strokes, for driving one ounce rockets, must be eight; and for two ounce rockets, twelve.

All rockets under one ounce, are not bored, but must be filled to the usual height, with composition, which is generally composed, of fine meal powder four ounces, and charcoal or steel dust two drams; the number of strokes for ramming these small swarmer, is not very material, so as they are rammed true, and moderately hard. The necks of unbored rockets, must be in the same proportion, as in common cases.

Of the cause of sky Rockets rising.



Having promised in the second section, to prove that the effect of sky rockets, and proportion of their charge, depends on the size of the cavity in the composition; I shall here endeavour to give a mathematical demonstration thereof.

Let

Let ABC be the hollow cone for the fire, $AYCZB$, the superficies of that cone, all the lines OZ at right angles with BC , all the lines OY at right angles with AC : now all the angles ZOY being towards R , whether the angles ZOY are obtuse or acute, but the more acute the better. The rays of fire ZO and YO issuing from the sides of the cone BC and AC , and continually acting with the greater force one upon another at O , forcing the whole BCA upward from the point R ; and the wider the cone is, (so as not to exceed one third at bottom, and one sixth at top, of the exterior diameter of the rocket,) the greater velocity will the rocket rise with.

Of Stands for Sky Rockets.

Care must be taken, in placing the rockets, when they are to be fired, in order to give them a vertical direction at their first setting out; which may be managed thus. Have two rails of wood, of any length, supported, at each end, by a perpendicular leg, so that the rails be horizontal, and let the distance from one to the other, be almost equal to the

L 4

length

length of the sticks of the rockets, intended to be fired; then in the front of the top rail, drive square hooks at eight inches distance from one another, with their points turning sideways, so that when the rockets are hung on them, the points will be before the sticks, and keep them from falling, or being blown off by the wind; in the front of the rail at bottom, must be staples, drove perpendicular under the hooks at top; through these staples, put the small ends of the rocket sticks. Rockets are fired by applying a lighted port fire, to their mouths.

N. B. When sky rockets are made to perfection, and fired, they will stand two or three seconds on the hook before they rise, and then mount up briskly, with a steady motion, carrying a large tail from the ground all the way up, and just as they turn, break and disperse the stars.

Of Griandole Chests, for flights of Rockets.

Griandole chests, are generally composed of four sides, of equal dimensions, but

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but may be made of any diameter, according to the number of rockets, designed to be fired; its height must be in proportion to the rockets, but must always be a little higher than the rockets, with their sticks; when the sides are joined, fix in the top, as far down the chest as the length of one of the rockets with its cap on. In this top, make as many square or round holes, to receive the rocket sticks, as you intend to have rockets, but let the distance between them, be sufficient for the rockets to stand without touching one another; then from one hole to another, cut a groove, large enough for a quick-match to lay in: the top being thus fixed, put in the bottom, at about one foot and a half distance from the bottom of the chest; in this bottom must be as many holes, as in the top, and all to correspond, but these holes need not be so large, as those in the top.

To prepare your chest, you must lay a quick-match, in all the grooves, from hole to hole; then take some sky rockets, and rub them in the mouth, with wet meal powder, and put a bit of match up the cavity of each, which match, must be long enough, to hang, a little below
the

the mouth of the rocket ; your rockets and chest being prepared, according to the above directions, put the sticks of the rockets, through the holes in the top and bottom of the chest, so that their mouths may rest on the quick-match in the grooves ; by which all the rockets, will be fired at once ; for by giving fire to any part of the match, it will communicate to all the rockets, in an instant. As it would be rather troublesome, to direct the sticks from the top, to the proper holes in the bottom, it will be necessary to have a small door in one of the sides, which when opened, you may see how to place the sticks. Flights of rockets, being seldom fired at the beginning of any fireworks, for which reason, they are in danger of being fired, by the sparks from wheels, &c. Therefore to preserve them, a cover should be made to fit on the chest, and the door in the side kept shut.

Of

Of Serpents or Snakes for Pots des Aigrettes, Small Mortars, Sky Rockets, &c.

Serpents for this use, are made from two inches and an half, to seven inches in length, and their formers from three sixteenths, to five eighths of an inch diameter, but the diameter of the cases, must always be equal to two diameters of the former; they are rolled and choaked like other cases, and filled with composition from five eighths of an inch, to one inch and an half high, according to the size of the mortars, or rockets, they are designed for, and the remainder of the cases, bounced with corn-powder, and afterwards their ends pinched and tied close: before they are used their mouths must be primed with wet meal-powder.

Of Leaders, or Pipes of Communication.

The best paper for leaders, is a large sort of white paper, called Elephant, which

which you cut into long slips, two or three inches broad, so that they may go three or four times round the former, (but not more) for when they are very thick, they are too strong for the paper which fastens them to the works, and will sometimes fly off, without leading the fire: the formers for these leaders, are made from two, to six sixteenths of an inch diameter, but four sixteenths is the size generally made use of; the formers are made of smooth brass wire; when you use them, rub them over with grease, or keep them wet with paste, to prevent their sticking to the paper, which must be pasted all over; in rolling of pipes, make use of a rolling board, but use it lightly; having rolled a pipe, draw out the former with one hand, holding the pipe, as light as possible with the other, for if it press against the former, it will stick and tear the paper.

N. B. Make your leaders of different lengths, or in cloathing of works, you will cut a great many to waste. Leaders for marron Batteries must be made of strong cartridge paper.

SECT.

S E C T. V.

Of Aquatick Fireworks.

ALL works that shew themselves in the water, are much admired by most people who are fond of fireworks, particularly water rockets; but as these seem of a very extraordinary nature to those who are acquainted with this art, I shall endeavour to explain the method of making them, in as full and easy a manner as possible, as well as other devices for the water.

Of Water Rockets.

Water rockets may be made from four ounces. to two pound, but if larger they are too heavy, so that it will be difficult

difficult to make them keep above water, without a cork float, which must be tied to the neck of the case, but the rockets will not dive so well with, as without floats.

Cases for water rockets, are made in the same manner and proportion as sky rockets, only a little thicker of paper; when you fill these rockets which are drove solid, put in first, one ladle full of slow fire, then two of the proper charge, and on that one or two ladles of sinking charge, then the proper charge, then the sinking charge again, and so on, till you have filled the case within three diameters; then drive on the composition, one ladle full of clay, through which make a small hole to the charge, then fill the case, within half a diameter with corn powder, on which turn down two or three rounds of the case in the inside, then pinch and tie the end very tight; having filled your rockets, (according to the above directions) dip their ends in in melted rosin, or sealing wax, or else secure them well with grease. When you fire these rockets, throw in six, or eight at a time; but if you would have them all sink, or swim, at the same time, you must drive them with an equal

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qual quantity of composition, and fire them all together.

To make Pipes of Communication, which may be used under Water.

Pipes for this purpose, must be a little thicker of paper, than those for land works; having rolled a sufficient number of pipes, and kept them till thoroughly dry, wash them over with drying oil, and set them to dry; but when you oil them, leave about an inch and a half, at each end dry, for joints; for if they were oiled all over, when you come to join them, the paste would not stick, where the paper is greasy; after the leaders are joined, and the paste dry, oil the joints. These sort of pipes will lay many hours under water, without receiving any damage.

Of Horizontal Wheels for the Water.

First get a large wooden bowl without a handle, then have an octogon wheel
made

made of a flat board, eighteen inches diameter, so that the length of each side will be near seven inches ; in all the sides cut a groove for the cases to lie in, this wheel being made, nail it on the top of the bowl, then take eight four ounce cases, filled with a proper charge, each about six inches in length. Now to cloath the wheel with these cases, get some whitish-brown paper, and cut it into slips, four or five inches broad, and seven or eight long, these slips being pasted all over on one side, take one of the cases, and roll one of the slips of paper, about an inch and a half on its end, so that there will remain about two inches and a half of the paper hollow from the end of the case, this case tie on one of the sides of the wheel, near the corners of which, must be holes bored, through which you put the pack-thread to tie the cases ; having tied on the first case at the neck and end, put a little meal-powder in the hollow paper, then paste a slip of paper on the end of another case, the head of which put into the hollow paper on the first, allowing a sufficient distance from the tail of one, to the head of the other, for the pasted paper, to bend without tearing ; the second case tie on

as you did the first, and so on with the rest, except the last, which must be closed at the end, unless it is to communicate to any thing on top of the wheel; such as fire-pumps or brilliant fires, fixed in holes, cut in the wheel, and fired by the last or second case, as the fancy directs: six, eight, or any number may be placed on the top of the wheel, so that they are not too heavy for the bowl.

Before you tie on the cases cut the upper part of all their ends, except the last, a little shelving, that the fire from one, may play over the other, without being obstructed by the case. Wheel cases, have no clay drove in their ends nor pinched, but are always left open, only the last, or those which are not to lead fire, which must be well secured.

Of Mines for the Water.

For these sort of mines you must have a bowl, with a wheel on it, made in the same manner, as the water wheel, only in the middle of the wheel must be a hole, of the same diameter you design to have the mine; those mines are nothing more than a tin pot, with a strong bot-

M

tom.

tom, and a little more than two diameters in length; your mine must be fixed in the hole in the wheel, with its bottom resting on the bowl; then loaded with serpents, crackers, stars, small water rockets, &c. In the same manner as pots des aigrettes, but in their center, fix a case of Chinese fire, or a small gerbe, which must be lighted at the beginning of the last case on the wheel. These sort of wheels are to be cloathed as usual.

Of Fire Globes for the Water.

Bowls for water globes, must be very large, and the wheels on them of a decagon form, on each side of which nail a piece of wood four inches long, and on the outside of each piece cut a groove, wide enough to receive about one fourth of the thickness of a four ounce case; these pieces of wood must be nailed, in the middle of each face of the wheel, and fixed in an oblique direction, so that the fire from the cases may incline upwards; the wheel being thus prepared, tie in each groove a four ounce case, fill'd with a grey charge, then carry a leader
from

from the tail of one case to the mouth of the other.

Globes for these wheels, are made of two tin hoops, with their edges outwards, fixed one within the other, at right angles. The diameter of these hoops must be somewhat less than that of the wheel. Having made a globe, drive in the center of a wheel, an iron spindle, which must stand perpendicular, and its length, four or six inches more than the diameter of the globe.

This spindle serves for an axis, on which the globe is fixed, which, when done, must stand four or six inches from the wheel; round one side of each hoop, must be soldered, little bits of tin, two inches and a half distance from each other, which pieces must be two inches in length each, and only fastened at one end, the other ends being left loose, to turn round the small port fires and hold them on: these port fires must be made of such a length, as will last out the cases on the wheel. You are to observe that there need not be any port fires, at the bottom of the globe within four inches of the spindle, for if there were, they would have no effect, but only burn the wheel; all the port fires, must

be placed perpendicular from the center of the globe, with their mouths outwards; and must all be cloathed with leaders, so as all to take fire with the second case of the wheel; which cases must burn two at a time, one opposite the other. When two cases of a wheel begin together, two will end together; therefore the two opposite end cases, must have their ends pinched and secured from fire. The method of firing wheels of this sort, is, by carrying a leader from the mouth, of one of the first cases, to that of the other, which leader being burnt through the middle, will give fire to both at the same time.

Of Odoriferous Water Ballóons.

These sort of Ballóons, are made in the same manner, as air Ballóons, but very thin of paper, and in diameter one inch and three quarters, with a vent of half an inch diameter. The shells being made, and quite dry, fill them with any of the following compositions, which must be rammed in tight: these sort of Ballóons, must be fired at the vent, and put into a bowl of water. Odoriferous works, are generally fired in rooms.

Com-

Composition I.

Salt petre two ounces, flower of sulphur one ounce, camphor half an ounce, yellow-amber half an ounce, charcoal-dust, three quarters of an ounce, flower of benjamin, or assa odorata half an ounce, all powdered very fine ; and mixed well together.

Composition II.

Salt petre twelve ounces, meal powder three ounces, frankincense one ounce, myrrh half an ounce, camphor half an ounce, charcoal three ounces, all moistened with the oil of spike.

Composition III.

Salt petre two ounces, sulphur half an ounce, antimony half an ounce, amber half an ounce, cedar raspings a quarter of an ounce, all mixed with the oil of roses, and a few drops of bergamot.

Composition IV.

Salt petre four ounces, sulphur one ounce, saw-duft of juniper half an ounce, saw-duft of cypress one ounce, camphor a quarter of an ounce, myrrh two drams, dried rosemary a quarter of an ounce, cortex-elaterii half an ounce, all moistened a little with the oil of roses.

N. B. Water rockets, may be made with any of the above compositions, with a little alteration, to make them weaker, or stronger, according to the size of the cases.

Of Water Ballóons.

Having made some thin paper shells, of what diameter you please, fill some with the composition for water ballóons, and some after this manner. Having made the vent of the shells pretty large, fill them almost full with water rockets, marrons, squibs, &c. Then put in some blowing powder, sufficient to burst the shells, and afterwards fix in the vent a water rocket, long enough to reach the bottom of the shell, and its neck to project

ject a little out of the vent; this rocket must be open at the end, in order to fire the powder in the shell, which will burst the shell, and disperse the small rockets, &c. in the water. When you have well secured the large rocket, in the vent of the shell; take a cork float, with a hole in its middle, which fit over the head of the rocket, and fasten it to the shell: this float, must be large enough to keep the ballóon above water.

Of water Squibs.

Water squibs, are generally made of one ounce serpent cases, seven or eight inches long, filled two thirds with charge, and the remainder bounced; the common method of firing them, is thus: Take a water wheel, with a tin mortar in its center, which load with squibs, after the usual method, but the powder in the mortar, must be no more than will just throw the squibs out, (easily into the water), you may place the cases on the wheel, either obliquely, or horizontally; and on the top of the wheel, round the mortar, fix six cases of brilliant fire, perpendicular to the wheel;

M 4

these

these cases, must be fired, at the beginning of the last case of the wheel, and the mortar, at the conclusion of the same.

To represent a sea fight with small ships, and to prepare a fire-ship for the same.

Having procured four, or five, small ships, of two, or three feet in length, (or as many as you design to fight) make a number of small reports, which are to serve for guns. Of these, range as many as you please, on each side of the upper decks; then at the head and stern of each ship, fix a two ounce case, eight inches long, filled with a slow port-fire receipt, but take care to place it, in such a manner, that the fire may fall in the water, and not burn the rigging; in these cases, bore holes at unequal distances, from one another, but make as many in each case, as half the number of reports, so that one case may fire the guns, on one side, and the other those on the opposite. The method of firing the guns, is, by carrying a leader, from the holes in the cases, to the reports on the decks; you

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must make these leaders very small, and be careful in calculating the burning of the slow fire, in the regulating cases, that more than two guns, be not fired at a time. When you would have a broad-side given, let a leader be carried to a cracker, placed on the outside of the ship, which cracker must be tied loose, or the reports will be too slow; in all the ships put artificial guns, at the port holes.

Having filled, and bored holes, in two port fires, for regulating the guns, in one ship; make all the rest exactly the same; then when you begin the engagement, light one ship first, and set it a sailing, and so on with the rest, sending them out singly, which will make them fire regularly, at different times, without confusion, for the time between the firing of each gun, will be equal to that of lighting the slow fires.

The fire ship, may be of any size, and need not be very good, for it is always lost in the action. To prepare a ship for this purpose, make a port fire equal in size, with them in the other ships, and place it at the stern; in every port, place a large port fire, filled with a very strong composition, and painted in imitation of
a gun,

a gun, and let them all be fired at once by a leader from the slow fire, within two, or three diameters of its bottom; all along both sides, on the top of the upper deck, lay star composition about half an inch in thickness, and one in breadth, which must be wetted with thin size, then primed with meal powder, and secured from fire, by pasting paper over it; in the place where you lay this composition, drive some little tacks with flat heads, in order to hold it fast to the deck, this must be fired just after the sham guns, and when burning will shew a flame all round the ship; at the head take up the decks, and put in a tin mortar loaded with crackers, which mortar must be fired by a pipe, from the end of the slow fire; the firing of this mortar will sink the ship, and make a pretty conclusion. The regulating port fire of this ship, must be lighted at the same time, with the first fighting ship.

Having prepared all the ships for fighting; we shall next proceed with the management of them, when on the water. At one end of the pond, just under the surface of the water, fix two running blocks, at what distance you chuse the
ships

ships should fight ; and at the other end of the pond, opposite to each of these blocks, under the water, fix a double block ; then on the land, by each of the double blocks, place two small windlafs's ; round one of them, turn one end of a small cord, and the other end, put through one of the blocks ; then carry it through the single one, at the opposite end of the pond, and bring it back through the double block, again, and, round the other windlafs ; to this cord, near the double block, tie as many small strings, as half the number of the ships, at what distance you think proper, but these strings, must not be more than two feet in length each ; the loose end of each of these cords, make fast, to a ship, just under her bow-sprit ; but if tied to the keel, or too near the water, it will upset the ship. Half the ships, being thus prepared, near the other double block, fix two more windlafs's, to which fasten a cord, and to it tie the other half of the ships, as before directed : when you fire the ships, pull in the cord, with one of the windlafs's, in order to get all the ships together ; and when you have set fire to the first, turn that windlafs, which draws them out,
and

and so on with the rest, till they are all out, in the middle of the pond ; then by turning the other windlafs, you will draw them back again, by which method you may make them change sides, and tack about, backwards and forwards, at pleasure. For the fire-ship, fix the blocks and windlafs's, betwixt the others, so that when she sails out, she will be between the other ships : you must not let this ship, advance, till the guns, at her ports take fire.

To fire Sky Rockets under water.

To fire sky rockets, under water, you must have stands made as usual, only the rails must be placed flat, instead of edge ways, and have holes in them for the rocket sticks to go through ; for if they were hung upon hooks, the motion of the water, would throw them off ; the stands being made, if the pond is deep enough, sink them at the sides, so deep, that when the rockets are in, their heads, may just appear above the surface of the water ; to the mouth of each rocket, fix a leader, which put through the hole with the stick ; then a little above
the

ARTIFICIAL FIREWORKS. 173

the water, must be a board, supported by the stand, and placed along one side of the rockets, then the ends of the leaders, are turned up through holes made in this board, exactly opposite the rockets. By this means, you may fire them singly, or all at once. Rockets may be fired by this method, in the middle of a pond, by a Neptune, a swan, a water wheel, or any thing else you chuse.

To represent Neptune in his Chariot.

In order to represent this, to perfection, you must have a Neptune made (of wood, or basket work), as big as life, fixed on a float, large enough to bear his weight ; on which must be two horses heads, and necks, so as to seem swimming, as they are shown by Fig. 35. For the wheels of the chariot, there must be two vertical wheels, of black fire, and on Neptune's head a horizontal wheel, of brilliant fire, with all its cases to play upwards. When this wheel is made, cover it with paper, or, paste board, cut and painted like Neptune's
coro-

coronet; then let the trident be made without prongs, but instead of them, fix three cases of a weak grey charge, and on each horse's head, put an eight ounce case of brilliant fire, and on the mouth of each, fix a short case of the same diameter, filled with the white flame receipt, enough to last out all the cases on the wheels; these short cases must be open at bottom, that they may light the brilliant fires; for the horses eyes, put small port fires, and in each nostril, put a small case filled half with grey charge, and the rest with port fire composition.

If Neptune is to give fire, to any building on the water; at his first setting out, the wheels of the chariot, and that on his head, together with the white flames on the horses head, and the port fires in their eyes and nostrils, must all be lighted at once; then from the bottom of the white flames, carry a leader, to the trident. As Neptune is to advance by the help of a block and cord, you must manage it so as not to let him turn about, till the brilliant fires on the horses, and the trident, begins, for it is by the fire from the horses, (which plays almost upright) that the building, or work, is lighted;

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lighted; which must be thus prepared. From the mouth of the case, which is to be first fired, hang some loose quick match, to receive the fire from the horses. When Neptune, is only to be shewn by himself, without setting fire to any other works; let the white flames on the horses, be very short, and not to last longer than one case of each wheel, and let two cases of each wheel burn at a time.

To represent Swans and Ducks in the water.

If you would have the swans, or ducks, discharge rockets into the water, they must be made hollow, and of paper, and filled with small water rockets, with some blowing powder, to throw them out; but if this is not done, they may be made of wood, which will last many times. Having made and painted some swans, fix them on floats, then in the places where their eyes should be, bore holes, two inches deep, inclining downwards, and wide enough to receive a small port fire; the port fire cases for
this

this purpose, must be made of brass, two inches in length and filled with a slow bright charge; in the middle of one of these cases, make a little hole, then put the port fire, in the eye hole of the swan, leaving about half an inch to project out, and in the other eye put another port fire, with a hole made in it; then in the neck of the swan, within two inches of one of the eyes, bore a hole slantways, to meet that in the port fire; in this hole put a leader, and carry it to a water rocket, that must be fixed under the tail with its mouth upwards; on the top of the head, place two one ounce cases, four inches in length each, drove with brilliant fire; one of these cases must incline forwards, and the other backwards; these must be lighted at the same time as the water rocket; to do which, bore a hole between them, in the top of the swans head, down to the hole in the port fire, to which carry a leader; if the swan be filled with rockets, they must be fired, by a pipe, from the end of the water rocket under the tail. When you set the swan a swimming light the two eyes.

Of

Of fire Fountains for the Water.

To make a fire fountain, you must first have a float made of wood, three feet diameter, then in the middle of it, fix a round perpendicular post, four feet in height, and two inches diameter; round this post, fix three circular wheels, made of thin wood, without any spokes. The largest of these wheels must be placed, within two, or three inches of the float, and must be nearly of the same diameter. The second wheel must be two foot two inches diameter, and fixed at two feet distance from the first wheel. The third wheel must be one foot four inches diameter, and fixed within six inches of the top of the post: the wheels being fixed, take eighteen four, or eight ounce cases, of brilliant fire, and place them round the first wheel, with their mouths outwards, and inclining downwards; on the second wheel place, thirteen cases of the same sort, and in the same manner, as those on the first wheel; on the third wheel, place eight more of this sort of cases, in the same manner

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as

as before, and on the top of the post, fix a gerbe, then cloath all the cafes, with leaders, so that both they and the gerbe; may take fire at the same time. Before you fire this work, try it in the water, to see if the float be properly made, so as to keep the fountain upright.

SECT.

SECT. VI.

To make Crackers.

CUT some cartridge paper, into pieces, three inches and a half broad, and one foot long; one edge of each of these pieces, fold down lengthwise about three quarters of an inch broad; then fold the double edge down a quarter of an inch, and turn the single edge back half over the double fold; then open it, and lay all along the channel which is formed, by the folding of the paper, some meal powder, then fold it over and over, till all the paper is doubled up, rubbing it down every turn; this being done, bend it backwards and forwards, two inches and a half, or thereabouts, at a time, as often as the paper will allow; then hold all these folds

N 2

flat

flat and close, and with a small pinching cord, give one turn round the middle of the cracker, and pinch it close, then bind it with pack-thread, as tight as you can then in the place where it was pinched, prime one end of it, and cap it with touch paper. When these crackers are fired they will give a report, at every turn of the paper: if you would have a great number of bounces, you must cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you must have a piece of wood, with a groove in it, deep enough to let in half the cracker, this will hold it straight, while it is pinching. Fig. 36. represents a cracker compleat.

Of Single Reports.

Cases for reports are generally rolled on one and two ounce formers, and are seldom made larger, but on particular occasions; they are made from two, to four inches long, and very thick of paper; having rolled a case, pinch one end quite close, and drive it down, then fill the case with corn powder, only leaving
room

room to pinch it at top, but before you pinch it, put in a piece of paper at top of the powder: Reports are fired, by a vent, bored in the middle, or at one end, just as required.

Of Marrons.

Formers for marrons, are from three quarters of an inch, to one and a half diameter; cut the paper for the cases, twice the diameter of the former broad, and long enough to go three times round; when you have rolled a case, paste down the edge, and tie one end close, then with the former drive it down to take away the wrinkles and make it flat at bottom, then fill the case with corn powder one diameter and a quarter high, and fold down the rest of the case tight on the powder; the marron being thus made, wax some strong pack-thread, with shoemakers wax; this thread wind up in a ball, then unwind two, or three yards of it, and that part which is near the ball, make fast to a hook; then take a marron, and stand as far from the hook as the pack-thread will reach, and wind it lengthwise round

marron, as close as you can, till it will hold no more that way; then turn it, and wind the pack-thread on the short way, then lengthwise again, and so on till the paper is all covered; then make fast the end of the pack-thread, and beat down both ends of the marron, to bring it in shape. The method of firing marrons, is by making a hole at one end with an awl and putting in a piece of quick-match, then take a piece of strong paper, in which wrap up the marron, with two leaders, which must be put down to the vent, and the paper tied tight round them with small twine; these leaders are bent on each side, and their loose ends tied to other marrons, and are nailed in the middle to the rail of the stand, as may be seen by Fig. 37. The use of winding the pack-thread in a ball, is, that you may let it out as you want it, according to the quantity, the marron may require; and that it may not be tied in knots, which would spoil the marron.

Of

Of Marron Batteries.

Those batteries, if well managed, will keep time to a march, or a slow piece of musick. Marron batteries are made of several stands, with a number of cross rails, for the marrons, which are regulated by leaders, by cutting them of different lengths, and nailing them tight, or loose, according to the time of the musick. In marron batteries you must use the large and small sort of marrons, and the nails for the pipes, must have flat heads.

Of Line Rockets.

Line rockets are made and drove in the same manner as sky rockets, but have no heads, and the cases must be cut close to the clay; they are sometimes made with six, or seven changes, but in general not more than four, or five; the method of managing those rockets, is as follows; first have a piece of light wood, the length of one of the rockets, turned round about two inches and a half diameter, with a hole through the mid-

dle lengthwise, large enough for the line to go easily through; if you design four changes, have four grooves cut in the swivel, one opposite the other, to lay the rockets in.

The mouths of the rockets being rubbed with wet meal powder, lay them in the grooves, head to tail, and tie them fast; from the tail of the first rocket, carry a leader to the mouth of the second, and from the second to the third, and so on to as many as there are on the swivel, making every leader very secure, but in fixing these pipes take care, that the quick-match does not enter the bores of the rockets; the rockets being fixed on the swivel, and ready to be fired, have a line of a hundred yards in length, stretched and fixed up tight, at any height from the ground, but be sure to place it horizontal; this length of line will do for rockets of half a pound, but if larger, the line must be longer, before you put up the line, put one end of it through the swivel, and when you fire the line rocket, let the mouth of that rocket which you fire first, face that end of the line where you stand, then the first rocket will carry the rest to the other end of the line, and the second will bring them
back

back again, and so they will run out and in according to the number of rockets: at each end of the line, there must be a piece of flat wood, for the rocket to strike against, or its force would cut the line. Let the line be well soaped, and the hole in the swivel very smooth.

Of the different Decorations for Line Rockets.

To line rockets may be fixed many sorts of things, such as flying dragons, mercuries, ships, &c. Or they may be made to run on the line like a wheel, which is done in this manner; have a flat swivel, made very exact, and on it, tie two rockets obliquely, one on each side, which will make it turn round all the way it goes, and form a circle of fire; the charge for these rockets, should be a little weaker than common; if you would shew two dragons fighting, get two swivels made square, and on each tie three rockets together, on the under side; then have two flying dragons made of tin, and fix one of them on the top of each swivel, so as to stand upright; in the mouth of each dragon put a small
case

case of common fire, and another at the end of the tail; you may put two or three port fires of a strong charge, on one side of their bodies, in order to shew them. This being done put them on the line, one at each end; but let there be a swivel in the middle, of the line, to keep the dragons from striking together; before you fire the rockets light the cases on the dragons, and if care be taken in firing both at the same time, they will meet in the middle of the line, and seem to fight. Then they will run back, and return again, with great violence, which will have a very pleasing effect. The line for these rockets must be very long, or they will strike too hard together.

Of Chinese Flyers.

Cases for flyers, may be made of different sizes, from one to eight ounces; they must be made thick of paper, and eight interior diameters long; they are rolled in the same manner as tourbillons, with a straight pasted edge, and pinched close at one end; the method of filling them is thus; the case being put in a mould, whose cylinder, or foot, must be
flat

flat at top, without a nipple; fill it within half a diameter of the middle, then ram in half a diameter of clay, and on that as much composition as before, on which drive half a diameter of clay, then pinch the case close, and drive it down flat; after this is done, bore a hole, exactly through the center of the clay in the middle, then in the opposite sides at both ends make a vent, and in that side you intend to fire first make a small hole to the composition near the clay in the middle, from which carry a quick match covered with a single paper, to the vent at the other end; then when the charge is burnt on one side, it will, by means of the quick match communicate to the charge in the other, (which may be of a different sort). The flyers being thus made, put an iron pin, that must be fixed in the work on which they are to be fired, and on which they are to run; through the hole in the middle, on the end of this pin, must be a nut to keep the flyer from running off. If you would have them turn back again after they are burnt; make both the vents at the ends on the same side, which will alter its course, the contrary way.

Of

Of Table Rockets.

Table rockets are designed merely to shew the truth of driving, and the judgment of a fireworker, they having no other effect, when fired, than spinning round in the same place, where they begin; till they are burnt out, and shewing nothing more than an horizontal circle of fire.

The method of making these sort of rockets, is as follows: Have a cone turned out of hard wood, two inches and a half diameter, and as much in height; round the base of it draw a line, on this line fix four spokes, two inches in length each, so as to stand one opposite the other; then fill four nine inch one pound cases, with any strong composition, within two inches of the top, these cases are made like tourbillons, and must be rammed with the greatest exactness.

Your rockets being filled, fix their open ends on the short spokes, then in the side of each case bore a hole near the clay; all these holes, or vents, must be made in such a manner, that the fire
of

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of each case may act the same way; from these vents carry leaders to the top of the cone, and tie them together. When you would fire the rockets set them on a smooth table, and light the leaders in the middle, and all the cases will fire together (See fig. 38.) and spin on the point of the cone.

These rockets may be made to rise like tourbillons, by making the cases shorter, and boring four holes in the under side of each at equal distances from one another: this being done they are called double tourbillons.

Note, all the vents in the under side of the cases must be lighted at once; and the sharp point of the cone cut off, at which place make it spherical.

To make Wheels and other Works incombustible.

It being necessary, when your works are new, to paint them of some dark colour; therefore, if instead of which, you make use of the following composition, it will give them a good colour, and in a great measure prevent their taking fire so soon, as if painted. Take brick-dust,
coal

coal ashes, and iron filings, of each an equal quantity, and mix them together, with a double size, made hot. With this wash over your works, and when dry wash them over again; this will preserve the wood greatly against fire. Let the brick-dust, and ashes, be beat to a fine powder.

Of Single Vertical Wheels.

There are different sorts of vertical wheels, some having their fells of a circular form, others of an hexagon, octagon, or decagon form, or any number of sides, according to the length of the cases, you design for the wheel: your spokes being fixed in the nave, nail slips of tin, with their edges turned up, so as to form grooves for the cases to ly in, from the end of one spoke to another; then tie your cases in the grooves, head to tail, in the same manner as those on the horizontal water wheel, so that the cases successively taking fire from one another, will keep the wheel in an equal rotation. Two of these wheels are very often fired together, one on each side of a building, and both lighted at the

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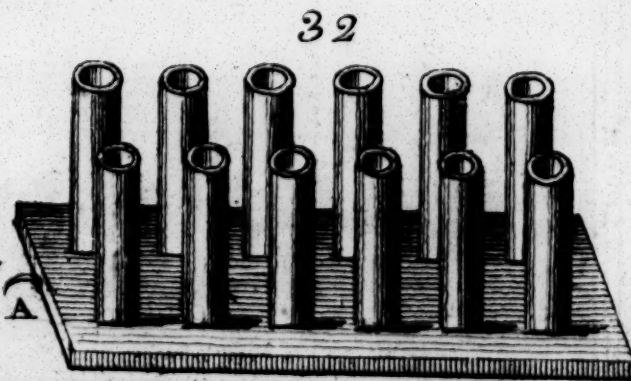
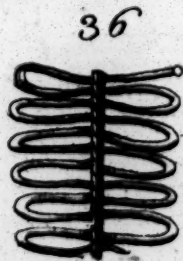
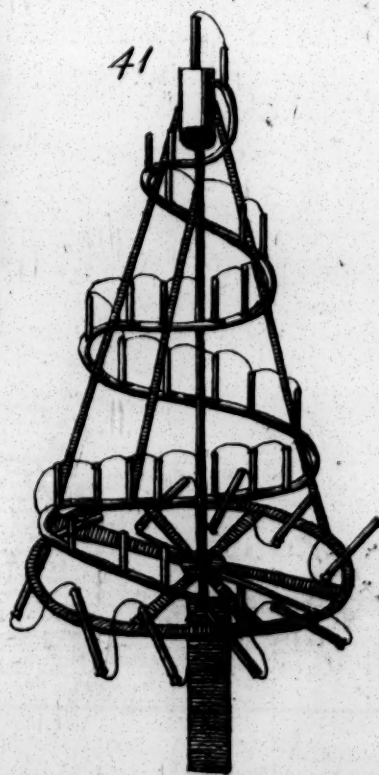
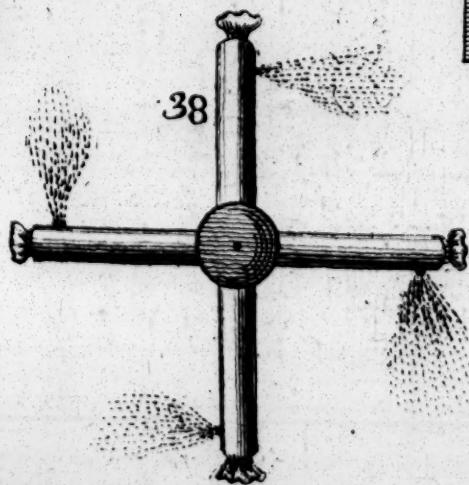
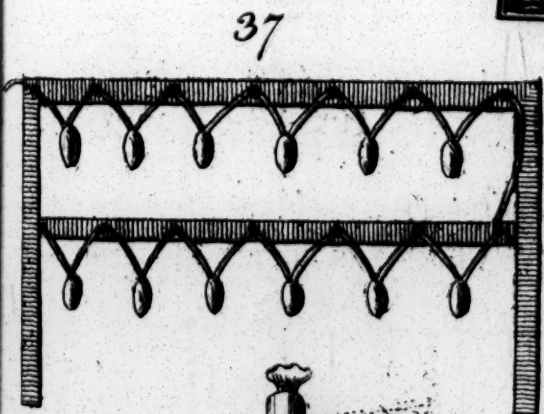
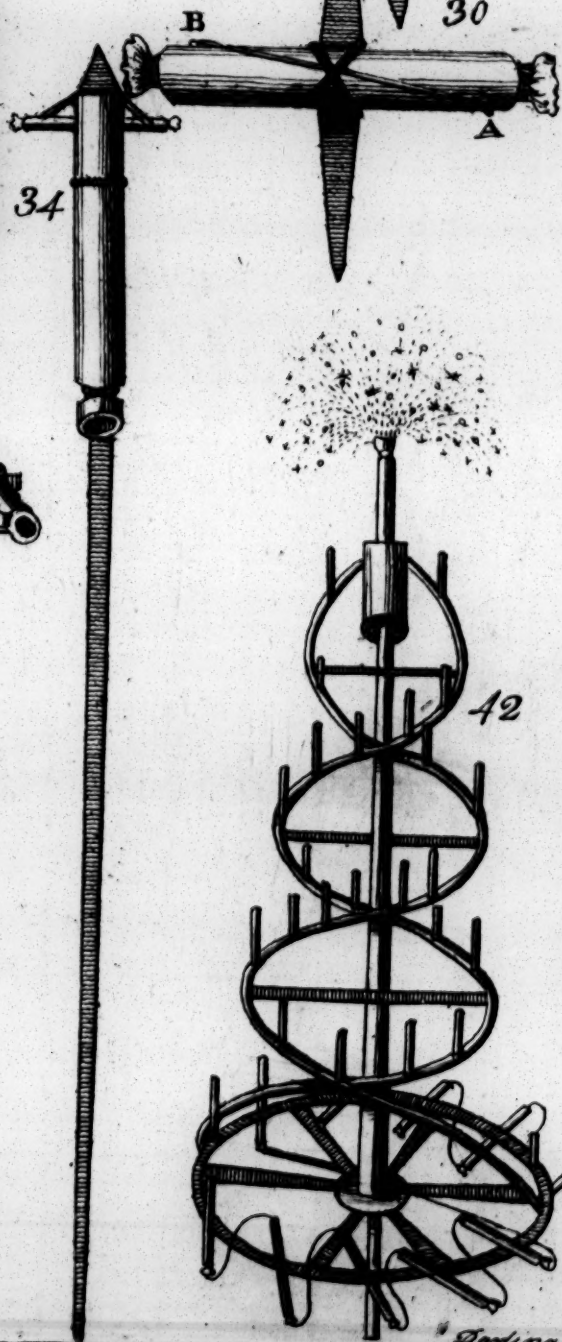
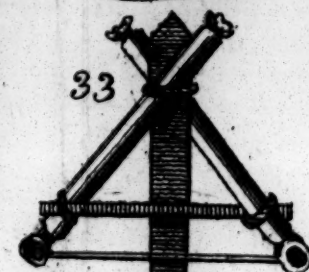
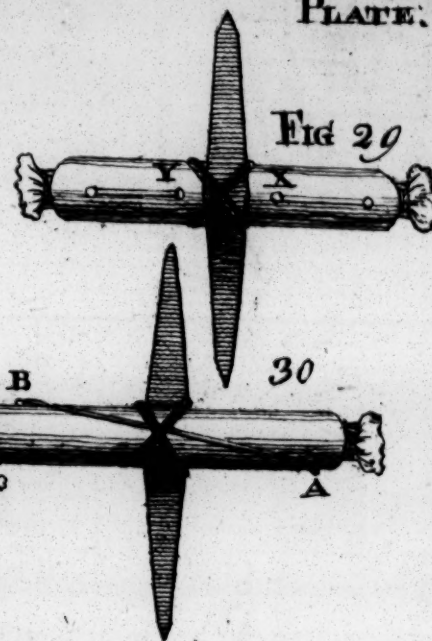
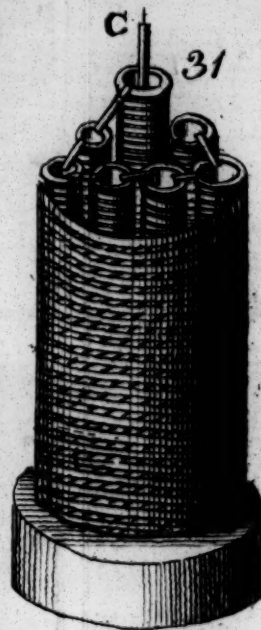
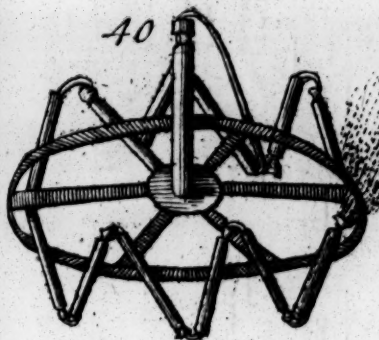
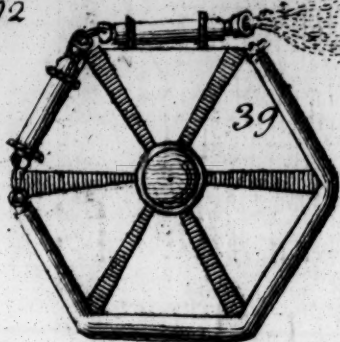
the same time, and all the cases filled alike, to make them keep time together, which they will do if made by the following directions. In all the cases of both wheels, except the first, on each wheel, drive two, or three ladles full of slow fire, in any part of the cases, but be carefull to ram the same quantity in each case, and in the end of one of the cases, on each wheel, you may ram one ladle full of dead fire composition, which must be very lightly drove; you may also make many changes of fire, by this method.

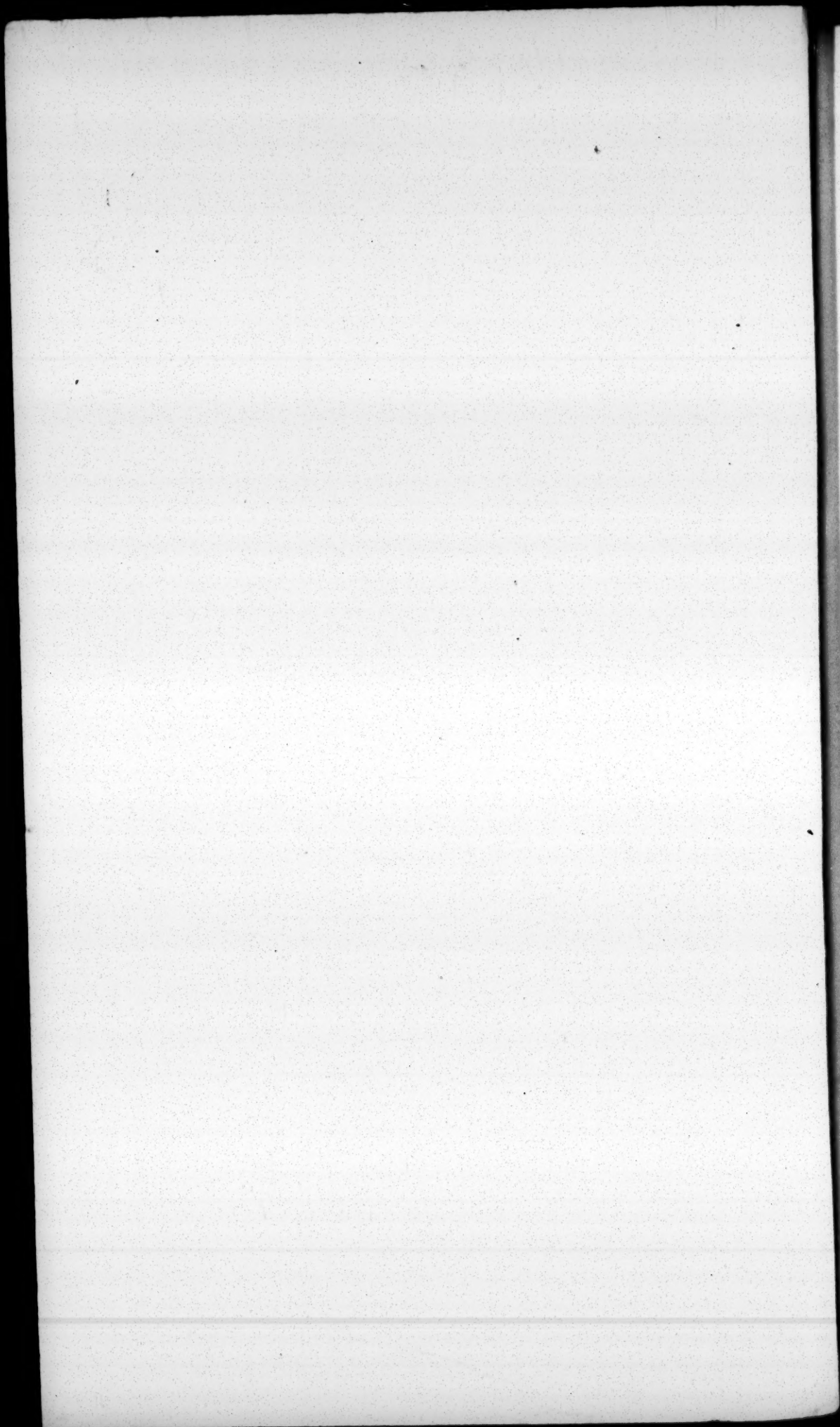
Let the hole in the nave of the wheel be lined with brass, and made to turn on a smooth iron spindle. On the end of this spindle let there be a nut, to screw off and on; when you have put the wheel on the spindle, screw on the nut, which will keep the wheel from flying off. Let the mouth of the first case be a little raised. See fig. 39. Vertical wheels are made from ten inches to three feet diameter, and the size of the cases must differ accordingly; four ounce cases, will do for wheels, of fourteen, or sixteen inches diameter, which is the proportion generally used. The best wood for wheels of all sorts, is a light, and dry beech.

Of

Of Horizontal Wheels.

Horizontal wheels are best when their fells are made circular; in the middle of the top of the nave, must be a pintle, turned out of the same piece as the nave, two inches long, and equal in diameter to the bore of one of the cases of the wheel; there must be a hole bored up the center of the nave, within half an inch of the top of the pintle; the wheel being made, nail at the end of each spoke (of which there should be six or eight) a piece of wood, with a groove cut in it to receive the case. These pieces fix in such a manner, that half the cases may incline upwards, and half downwards, and that when they are tied on, their heads and tails may come very near together; from the tail of one case, to the mouth of the other carry a leader, which secure with pasted paper. Besides these pipes, it will be necessary, to put a little meal powder inside the pasted paper, in order to blow off the pipe, that there may be no obstruction to the fire, from the cases. By means of these pipes, the cases, will successively take, burning





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ing one upwards, and the other downwards. On the pintle, fix a case of the same sort as those on the wheel; this case must be fired by a leader, from the mouth of the last case on the wheel, which case must play downwards: instead of a common case in the middle, you may put a case of Chinese fire, long enough, to burn as long as two or three of the cases on the wheel.

Horizontal wheels are often fired two at a time, and made to keep time, like vertical wheels, only they are made without any slow or dead fire; ten or twelve inches will be enough for the diameter of wheels, with six spokes. Fig. 40. represents a wheel on fire, with the first case burning.

Of spirali Wheels.

Spirali wheels are nothing more than double horizontal wheels, and are thus made: The nave must be about six inches long, and somewhat thicker than the single sort; instead of the pintle at top, there must be a hole for the case to be fixed in; there must also be two sets of spokes, one set near the top of the

O

nave,

nave, and the other near the bottom. At the end of each spoke cut a groove, wherein you tie the cases, there being no fell; the spokes should not be more than three inches and a half in length each from the nave, so that the wheel may not be more than eight or nine inches diameter; the cases are placed in such a manner, that those at top play down, and those at bottom to play up, but let the third or fourth case play horizontally. The case in the middle may begin with any of the others, you please; six spokes will be enough for each set, so that the wheel may consist of twelve cases, besides that on the top: the cases for these sort of wheels need not be more than six inches in length each.

Of Plural Wheels.

Plural wheels are made to turn horizontally, and to consist of three sets of spokes, placed in the following manner, six at top, six at bottom, and four in the middle, which must be a little shorter than the rest; let the diameter of the wheel be ten inches; the cases must be tied on the ends of the spokes, in grooves
cut

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cut on purpose, or in pieces of wood, nailed on the ends of the spokes, with grooves cut in them as usual; in cloathing these wheels, make the upper set of cases play obliquely downwards, and them at bottom obliquely upwards, and them in the middle horizontally. In placing the leaders, you must order it so that the cases may burn thus. viz. first up, then down, then horizontal, and so on with the rest, but another change may be made, by driving in the end of the eighth case, two, or three ladles full of slow fire, to burn till the wheel has stopped its course; then let the other cases be fixed the contrary way, which will make the wheel run back again: for the case at top, you may put a small gerbe; and let the cases on the spokes be short, and filled with a strong brilliant charge.

Of the Illuminated Spiral Wheel.

First have a circular horizontal wheel made two feet diameter, with a hole quite through the nave; then take three thin pieces of deal, three feet in length each, and three quarters of an inch in breadth each; one end of each of these

O 2

pieces,

pieces, nail to the fell of the wheel, at an equal distance from one another, and the other ends nail to a block with a hole in its bottom, which must be perpendicular, with that in the block of the wheel, but not so large. The wheel being thus made, have a hoop planed down very thin and flat, then nail one end of it to the fell of the wheel, and wind it round the three sticks in a spiral line, from the wheel to the block at top; on the top of this block fix a case of Chinese fire; on the wheel you may place any number of cases, which must incline downwards and burn two at a time. If the wheel should consist of ten cases, you may let the illuminations and Chinese fire begin with the second cases; the spindle for this wheel must be a little longer than the cone, and made very smooth at top, on which the upper block is to turn, and the whole weight of the wheel to rest, see fig. 41.

Of the Double Spiral Wheel.

For this wheel, the block, or nave, must be as long as the height of the worms, or spiral lines, but must be made
very

very thin, and as light as possible. In this block must be fixed several spokes, which must diminish in length, from the wheel to the top, so as not to exceed the surface of a cone of the same height. To the ends of these spokes nail the worms, which must cross each other several times; these worms cloath with illuminations, the same as those on the single wheels, but the horizontal wheel, you may cloath as you like. At top of the worm, place a case of spur-fire, or an amber light, see fig. 42. This figure is shewn without leaders, to prevent a confusion of lines.

Of Ballóon Wheels.

Ballóon wheels are made to turn horizontally, they must be made two feet diameter, without any spokes, and very strong, with any number of sides. On the top of a wheel range and fix tin pots, three inches diameter and seven inches in height each, as many of these as there are cases on the wheel; near the bottom of each pot, make a small vent, into each of these vents carry a leader from the tail of each case; some of the

pots load with stars, and some with serpents, crackers, &c. As the wheels turn, the pots will successively be fired, and throw into the air a great variety of fires.

Of Fruiloni Wheels.

First have a nave made nine inches in length, and three in diameter, near the bottom of this nave fix eight spokes, with a hole in the end of each large enough to receive a two, or four ounce case. Each of these spokes may be fourteen inches in length from the block; near the top of this block, fix eight more, of the same sort of spokes, exactly over the others, but not so long by two inches; as this wheel is to run horizontally, all the cases in the spokes, at top, must play obliquely upwards, and all them in the spokes at bottom obliquely downwards. This being done, have a small horizontal wheel made with eight spokes, each five inches in length from the block; on the top of this wheel, place a case of brilliant fire; all the cases on this wheel must play in an oblique direction downwards, and burn two at a time,

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time, and those on the large wheel, four at a time, that is, two of those in the top set of spokes, and two of them in the bottom set of spokes.

The four first cases on the large wheel, and the two first on the small wheel, must be fired at the same time, and the brilliant fire at top, at the beginning of the last cases. The cases of the wheels may be filled with a grey charge; when these wheels are completed, you must have a strong iron spindle, made four feet six in length, and fixed perpendicular on the top of a stand; on this put the large wheel, whose nave must have a hole quite through from the bottom to the top. This hole must be large enough to turn easy round the bottom of the spindle, at which place there must be a shoulder, to keep the wheel from touching the stand; at the top of the spindle, put the small wheel, and join it to a large one with a leader, in order to fire them them both together.

Of Port fires for Illuminations.

These sort of port fires, have their cases made very thin of paper, and rolled on formers, from two to five eighths of an inch diameter, and are made from two, to six inches in length; they are pinched close at one end, and left open at the other; when you fill them, put in but a little composition at a time, and ram it in lightly, so as not to break the case. Three or four rounds of paper, with the last round pasted, will be strong enough for these sort of cases.

Of Common port fires.

Common port fires are intended purposely to fire the works, their fire being very slow, and the heat of the flame so intense, that, if applied to rockets, leaders, &c, it will fire them immediately. Port fires may be made of any length, but are seldom made more than twenty one inches in length; the interior diameter of port fire moulds, should be ten sixteenths of an inch, and the diameter of the former, half an inch. The cases
2 must

must be rolled wet with paste, and one end of them pinched, or folded down. The moulds should be made of brass, and to take in two pieces lengthwise; then when the case is in the two sides, they are held together by brass rings, or hoops, which are made to fit over the outside. The bore of the mould must not be made quite through, so that there will be no occasion for a foot. Those port fires when used, are held in copper sockets, fixed on the end of a long stick; these sockets are made like port crayons, only with a screw, instead of a ring.

Of Cascades of Fire.

Cascades are made of any size, but one made according to the dimensions of that shewn in plate 4. fig. 43. will be large enough for eight ounce cases. Let the distance from A to B, be three feet; from B to C, two feet six inches; and from C D, two feet; and let the cross piece, at A, be four feet in length; then from each end of this piece, draw a line to D; then make the other cross pieces of such a length as to come within

within those lines. The top piece D, may be of any length so as to hold the cases, at a little distance from one another; all the cross pieces are fixed horizontally, and supported by brackets; the bottom cross piece should be about one foot six inches broad in the middle, the second one foot, the third nine inches, and the top piece four inches; the cases may be made of any length, but must be filled with a brilliant charge; on the edges of the cross pieces must be nailed bits of wood, with a groove cut in each piece, large enough, for a case to lie in. These bits of wood are fixed so as to incline downwards, and that the fire from one tier of cases may play over the other; all the cases being tied fast on, carry leaders from one to the other, and let there be a pipe, hang from the mouth of one of the cases, covered at the end with a single paper, which you burn to fire the cascade.

Of the Fire-Tree.

To make a fire-tree, as shewn by fig. 44. you must first have a piece of wood six feet in length, and three inches square,

square, then at E, nine inches from the top, make a hole in the front, and in each side, or instead of holes you may fix short pegs, to fit the inside of the cases. At F, nine inches from E, fix three more pegs; at G, one foot nine inches from F, fix three pegs; at H, nine inches from G, fix three pegs, inclining downwards, but all the other pegs, must incline upwards, in order that the cases may have the same inclination as you see in the figure; then at top place a four inch mortar, loaded with stars, rains, or crackers. In the middle of this mortar, place a case filled with any sort of charge, but let it be fired with the other cases: a brilliant charge will do for all the cases, but the mortar may be made of any diameter, and the tree of any size, and on it any number of cases, provided they are placed in the manner described.

Of Chinese Fountains.

To make a Chinese fountain, you must have a perpendicular piece of wood, seven feet in length, and two inches and a half square. Sixteen inches
from

from the top; fix on the front, a cross piece, one inch thick, and two and a half broad, with the broad side upwards; below this, fix three more pieces, of the same width and thickness, at sixteen inches distance from each other; let the bottom rail be five feet in length, and the others of such a length, as to allow the fire pumps to stand in the middle of the intervals of each other. The pyramid being thus made, fix in the holes made in the bottom rail, five fire pumps, at equal distances; on the second rail place four pumps; on the third, three; on the fourth, two; and on the top of the post, one; but place them all to incline a little forwards, that when they throw out the stars, they may not strike against the cross rails; having fixed your fire pumps, cloath them with leaders, so that they may all be fired together. see fig. 45.

Of

Of Illuminated Globes with Horizontal Wheels.

The hoops for these sort of globes, may be made of wood, tin, or iron wire, about two feet diameter; for a single globe take two hoops, and fasten them together, one within the other at right angles; then have a horizontal wheel made, whose diameter must be a little wider than the globe, and its nave six inches long, on the top of which the globe is fixed, so as to stand three or four inches from the wheel; on this wheel you may put any number of cases, fill'd with what charge you like, but let two of them burn at a time; they may be placed horizontally or to incline downwards just as you chuse. Now when the wheel is cloathed, fix on the hoops as many illuminations as will stand within two inches and a half of one another; these you fasten on the hoops, with small iron binding wire, and when they are all on, put on your pipes of communication, which must be so managed, as to light them

them all with the second or third case on the wheel; the spindle on which the globe is to run must go through the block of the wheel, up to the inside of the top of the globe, where must be fix'd a bit of brass or iron, with a hole in it to receive the point of the spindle, on which the whole weight of the wheel is to bear, as is shewn by fig. 46. which represents a globe on its spindle. By this method may be made a crown, which is done by having the hoops bent in the form of a crown. Sometimes globes and crowns, are ordered so as to stand still, and the wheel only to turn round; but when you would have the globe or crown to stand still, and the wheel to run by itself, the block of the wheel must not be so long, nor the spindle any longer than to just raise the globe a little above the wheel; and the wheel cases, and the illumination must begin together.

Of

Of the Dodecaedron.

This piece is called a dodecaedron, because it nearly represents a twelve sided figure, and is made thus. First have a ball turned out of some hard wood, fourteen inches diameter, when done, divide its surface into fourteen equal parts, from which bore holes, one inch and a half diameter, perpendicular to the center, so that they may all meet exactly in the middle; then let there be turned in the inside of each hole a female screw, and to all the holes but one, must be made a round spoke, five feet in length, with four inches of the screw at one end, to fit the holes; then in the screw end of all the spokes, bore a hole, five inches up, which must be bored slanting, so as to come out at one side, a little above the screw; from which cut a small groove along the spoke, within six inches of the other end, where you make another hole through to the other side of the spoke; in this end fix a spindle, on which put a small wheel, of three, or four sides, each side six or seven inches in

in length ; these fides must have grooves cut in them large enough to receive a two or four ounce case ; when these wheels are cloathed, put them on the spindles, and at the end of each spindle, put a nut to keep the wheel from falling off ; the wheels being thus fixed, carry a pipe from the mouth of the first case on each wheel, through the hole in the fide of the spoke, and from thence along the groove and through the other hole, so as to hang out at the screw end, about an inch. The spokes being all prepared in this manner, you must have a post, on which you intend to fire the work, with an iron screw in the top of it, to fit one of the holes, in the ball ; on this screw fix the ball, then in the top hole of the ball, put a little meal powder, and some loose quick match ; then screw in all the spokes, and in one fide of the ball bore a hole, in which put a leader, and secure it at the end, and your work will be ready to be fired. By this leader the powder and match in the center is fired, which will light the match at the ends of the spokes, all at once, whereby all the wheels will be lighted at one and the same time ; there may be an addition to this piece, by fixing a small globe, on each

each wheel, or one on the top wheel only. A grey charge will be proper for the wheel cases.

Of the Yew Tree of Brilliant Fire.

A yew tree of fire is represented by fig. 47. as it appears when burning; first, let A be an upright piece of wood, four feet in length, two inches broad and one thick; at top of this piece, on the flat side, fix a hoop, fourteen inches diameter, and round its edge and front place illuminations, and in the center a five pointed star; then at E, which is one foot and a half from the edge of the hoop, place two cases of brilliant fire, one on each side; these cases should be one foot in length each; below these, fix two more cases of the same size, and at such a distance that their mouths may almost meet them at top; then, close to the ends of these cases, fix two more of the same sort of cases; these must stand parallel to them at E. The cases being thus fixed, cloath them with leaders; so that they, with the illuminations and star at top, may all take fire together.

P

Of

Of Stars with Points for Regulated Pieces, &c.

These sort of stars are made of different sizes, according to the work for which they are intended; they are made with cases, from one ounce to one pound, but in general are made with four ounce cases, four or five inches in length; the cases must be rolled with paste, and twice as thick of paper as a rocket of the same bore. Having rolled a case, pinch one end of it quite close, then drive in half a diameter of clay, and when the case is dry, fill it with composition, two or three inches, according to the length of the cases, with which it is to burn; at top of the charge drive some clay; for, as the ends of these cases are seldom punched, they would be liable to take fire. Having filled a case, divide the circumference of it at the pinched end close to the clay into five equal parts; then bore five holes with a gimblet about the size of the neck of a common four ounce case into the composition; from one hole to the other, carry a quick match, and
secure

secure it with paper; this paper must be put on in the manner of that on the ends of wheel cases, so that the hollow part, which projects from the end of the case, may serve to receive a leader from any other work, in order to give fire to the points of the star. These sort of stars may be made with any number of points.

Of the Fixed Sun with a Transparent Face.

To make a sun of the best sort, there should be two rows of cases, as in fig. 48, which will shew a double glory, and make the rays strong and full; the frame or sun wheel, must be made after the following manner; have a circular flat nave made very strong, twelve inches diameter; to this fix six strong flat spokes, A, B, C, D, E, F. On the front of these fix a circular fell, five feet diameter. Within which fix another fell, the length of one of the sun cases less in diameter; within this fix a third fell, whose diameter must be less than the second, by the length of one case and one third; the wheel being made,

P 2

divide

divide the fells into as many equal parts as you would have cases (which may be done from twenty four, to forty four;) at each division, fix a flat iron staple; these staples must be made to fit the cases, so as to hold them fast on the wheel; let the staples be so placed, that one row of cases may lay in the middle of the intervals of the other.

In the center of the block of the sun, drive a spindle, on which put a small hexagon wheel, whose cases must be filled with the same charge, as the cases of the sun; two cases of this wheel must burn at a time, and begin with them on the fells; having fixed on all the cases, carry pipes of communication from one to the other, as you see in the figure, and from one side of the sun to the wheel in the middle, and from thence to the other side of the sun. These leaders will hold the wheel steady while the sun is fixing up, and will also be a sure method of lighting both cases of the wheel together. A sun thus made is called a brilliant sun, because the wood work is entirely covered with fire from the wheel in the middle, so that there appears nothing but sparks of brilliant fire; but if you would have a transparent

parent face in the center, you must have one made of paste board, of any size; the method of making a face is, by cutting out the eyes, nose, and mouth, for the sparks of the wheel to appear through; but, instead of this sort of face, you may have one painted on oiled paper, or Persian silk, strained tight on a hoop, which hoop must be supported by three or four pieces of wire, at six inches distance from the wheel in the center, so that the light of it may illuminate the face; by this method you may have in the front of a sun VIVAT REX, cut in paste board, or Apollo painted on silk, but for a small collection of fireworks, a sun with a single glory, and a wheel in front, will be most suitable. Half pound cases, filled ten inches with composition, will be a good size for a sun of five feet diameter; but if larger, the cases must be greater in proportion.

Of three Vertical Wheels Illuminated, which turn on their own Naves upon a Horizontal Table.

A plan of this is shewn by fig. 49. Let D be a deal table three feet six inches diameter; this table must be fixed horizontally on the top of a post; on the top of this post must be a perpendicular iron spindle, which must come through the center of the table; then let A, B, C, be three spokes joined to a triangular flat piece of wood, in the middle of which make a hole to fit easily over the spindle; let E, F, G, be pieces of wood, four or five inches in length each, and two inches square, fixed on the under sides of the spokes; in these pieces make holes lengthwise to receive the thin part of the blocks of the wheels, which when in, are prevented from coming out by a small iron pin being run through the end of each; K, L, M, are three vertical octagon wheels, eighteen inches diameter each; the blocks of these wheels must be long enough

enough for three or four inches to rest on the table, round which part drive a number of sharp points of wire, which must not project out of the blocks more than one sixteenth of an inch; the use of these points is, that when the blocks run round, they will stick in the table, and help the wheels forward; if the naves be made of strong wood, one inch will be enough for the diameter of the thin part, which should be made to turn easy in the holes in the pieces E, F, G. On the front of the wheels, make four or five circles of strong wire, or flat hoops, and tie on them as many illuminations as they will hold at two inches from one another; instead of circles, you may make spiral lines cloathed with illuminations at the same distance from one another, as those on the hoops: when illuminations are fixed on a spiral line in the front of a wheel, they must be placed a little on the slant, the contrary way that the wheel runs: the cases for these wheels may be filled with any coloured charge, but must burn only one at a time.

The wheels being thus prepared, you must have a globe, crown, or spiral wheel, to put on the spindle in the mid-

dle of the table; this spindle should be just long enough to raise the wheel of the globe, crown, or spiral wheel, so high that its fire may play over the three vertical wheels; by this means, their fires will not be confused, nor will the wheels receive any damage from the fire of each other; in cloathing this work, let the leaders be so managed, that all the wheels may light together, and the illuminations after two cases of each wheel are burnt.

Of the Illuminated Chandelier.

Illuminated works are much admired by the Italians, and indeed are a great addition to a collection of works; for in a grand exhibition an illuminated piece should be fired after every two, or three wheels, or fixed pieces of common and brilliant fires, and likewise illuminated works may be made cheap, quick, and easy.

To make an illuminated chandelier, you must first have one made of thin wood; see fig. 50. The chandelier being made, bore in the front of the branches, and in the body, and also in the

the crown at top, as many holes for illuminations as they will contain, at three inches distance from each other; in these holes put illuminations filled with white, blue, or brilliant charge; having fixed in the port fires, cloath them with leaders so that the chandelier and crown may light together. The small circles on this figure represent the mouths of the illuminations, which must project straight from the front.

Of the Illuminated Yew Tree.

First have a tree made of wood, such as is shewn by fig. 51. The middle piece or stem, on which the branches are fixed, must be eight feet six inches in height; at the bottom of this piece draw a line, at right angles, two feet six inches in length at each side; then from L, which is one foot six inches from the bottom, draw a line on each side to C and D; these lines will give the length of the two first branches. Then put on the two top branches parallel to them at bottom; let the length of each of these branches be one foot from the stem; from the ends of these two branches,

branches, draw a line to C and D ; then fix on five more branches at an equal distance from each other, and their length will be determined by the lines A C and E D ; when the branches are fixed, place illuminating port fires on the top of each, as many as you chuse : behind the top of the stem fasten a gerbe, or white fountain, which must be fired at the beginning of the illuminations on the tree.

Of Flaming Stars with Brilliant Wheels.

To make a flaming star, you must first have made a circular piece of strong wood, about one inch thick and two feet diameter ; round this block fix eight points, two feet six inches in length each ; four of these points must be straight, and four flaming ; these points being joined on very strong and even with the surface of the block, nail tin or paste board on their edges, from the block to the end of each, where they must be joined ; this tin must project in front eight inches, and be joined where they meet at the block ; round the

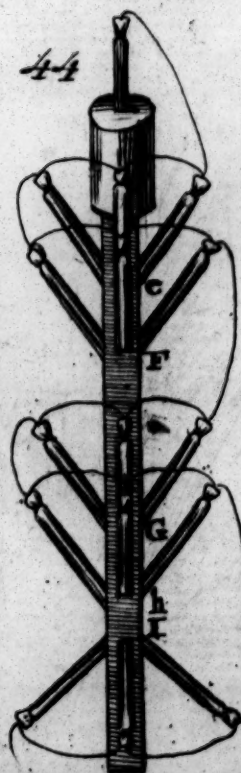
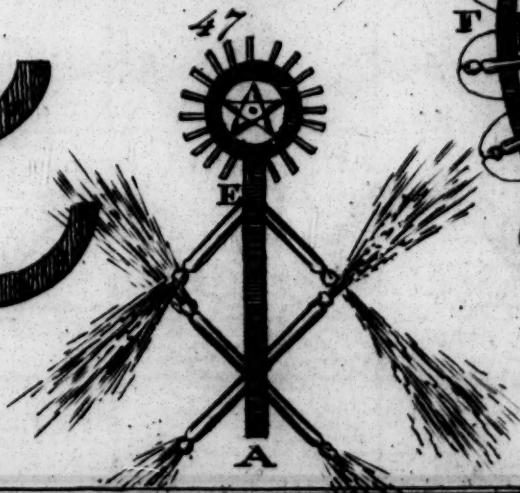
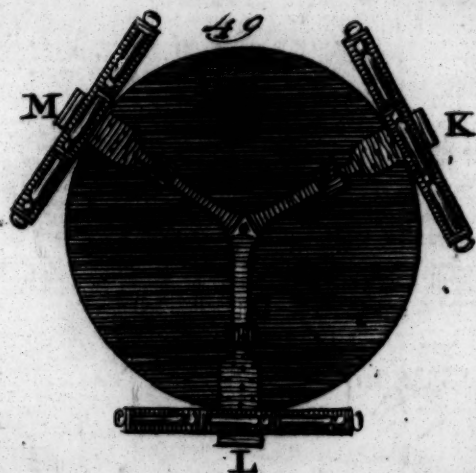
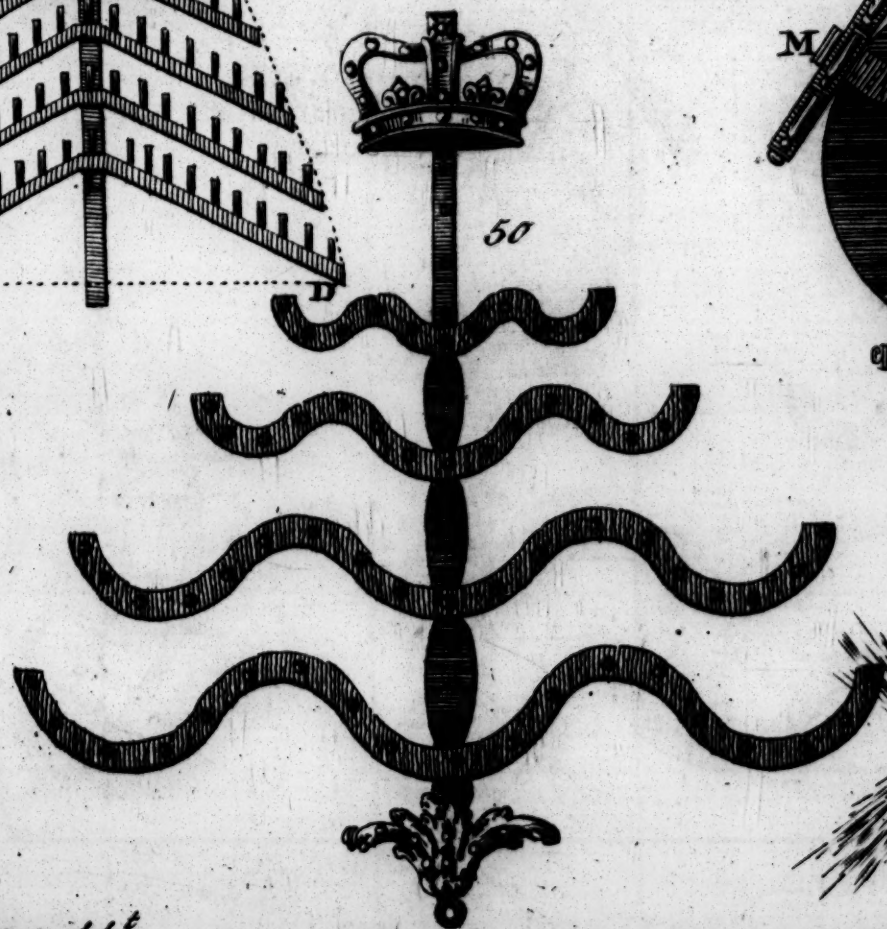
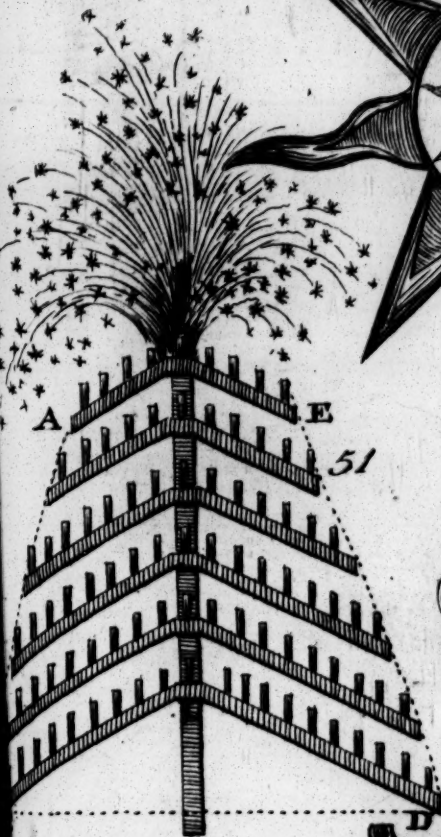
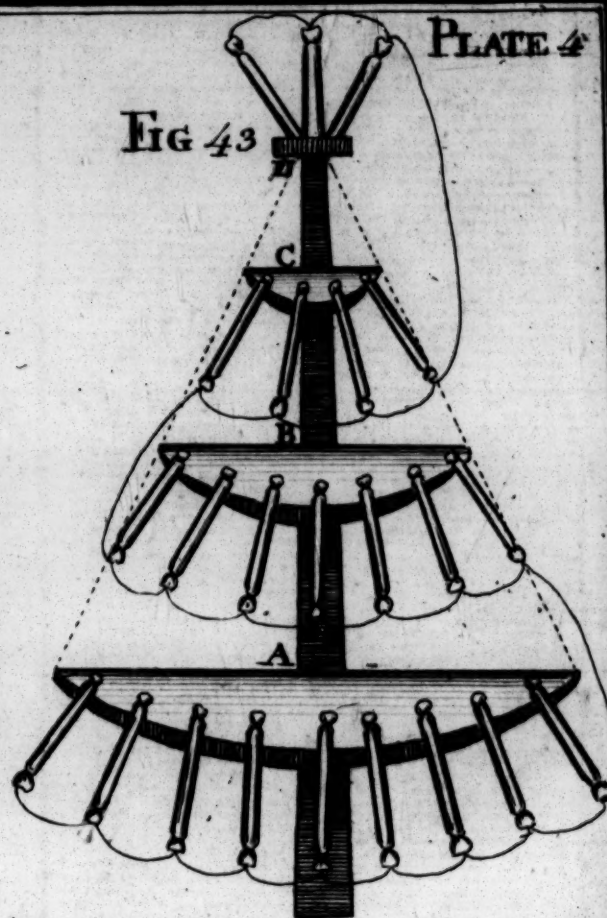
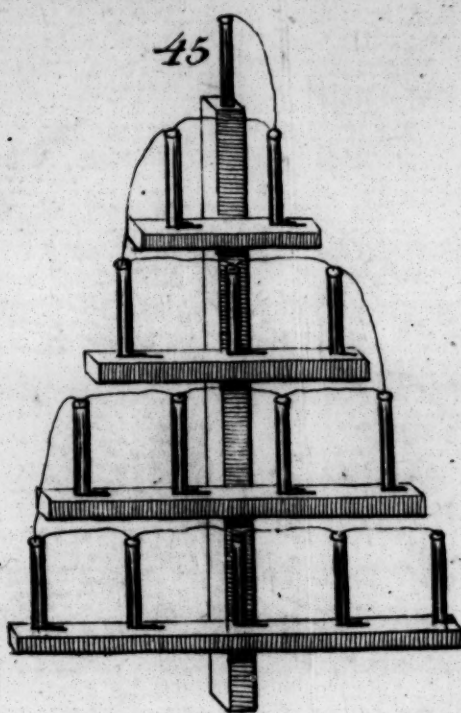
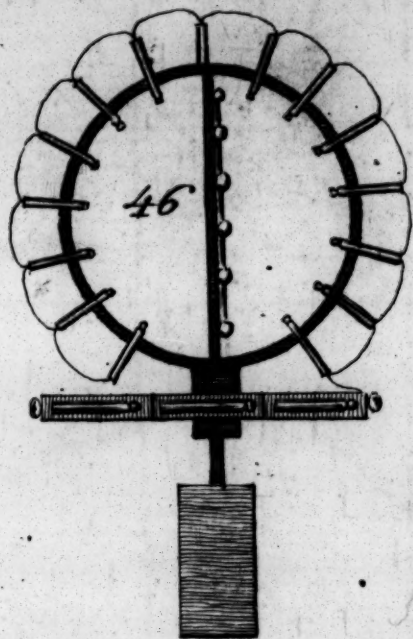
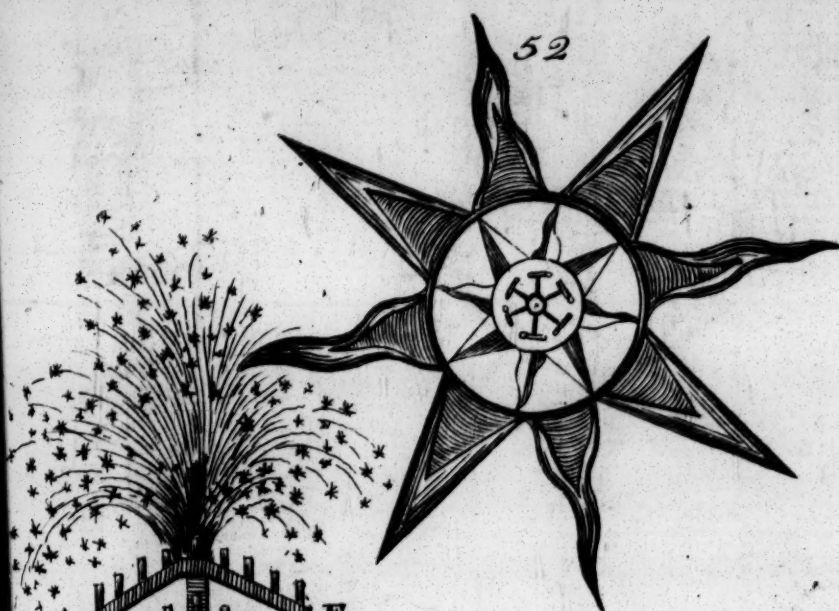
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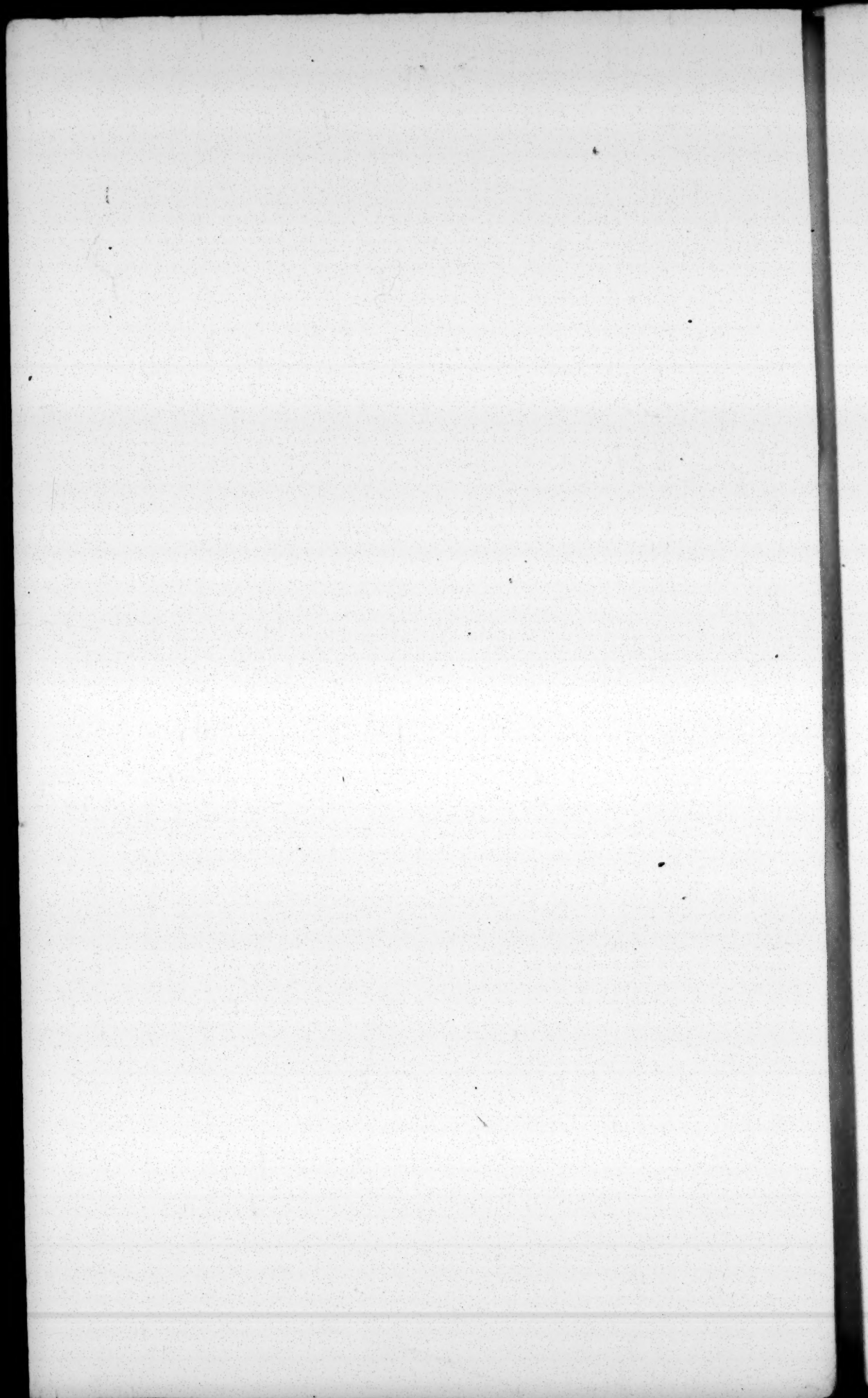
the front of the block fix four pieces of thick iron wire, eight inches in length each, equally distant from each other; this being done, cut a piece of paste board round two feet diameter, and draw on it a star, as may be seen in fig. 52. This star cut out, and on the back of it paste oiled paper, then paint each point half red, and half yellow, lengthwise; but the body of the star must be left open, wherein must run a brilliant wheel, which is made as follows: Have a light block turned nine inches long; at each end of it, fix six spokes, at the end of each spoke put a two ounce case of brilliant fire; the length of these cases must be in proportion to the wheel, and the diameter of the wheel when the cases are on must be a little less than the diameter of the body of the small star; the cases on the spokes in front must have their mouths incline outwards, and them on the inside spokes must be placed so as to form a vertical circle of fire. When you place your leaders, carry the first pipe from the tail of one of the cases in front to the mouth of one of the inside cases, and from the tail of that to another in front, and so on to all the cases; your wheel

wheel being made, put it on a spindle, exactly in the center of the star; this spindle must have a shoulder at bottom, to keep the wheel at a little distance from the block. This wheel must be kept on the spindle by a nut at the end; having fixed on the wheel, fasten the transparent star to the four pieces of wire; then when you fire the wheel, you will first see nothing more than a common horizontal wheel; but when the first case is burnt out, it will fire one of the vertical cases, which will shew the transparent star, and fill the large flames and points with fire; then it will again appear like a common wheel, and so on for twelve changes.

Of Touch Paper for Capping of Serpents, Crackers, &c.

Diffolve, in some spirits of wine or vinegar, a little salt petre, then take some purple or blue paper, and wet it with the above liquor, and when dry it will be fit for use; when you paste this paper, on any of your works, take care that the paste does not touch that part which is to burn. The method of using
this





this paper is by cutting it into slips, long enough to go once round the mouth of a serpent, cracker, &c. When you paste on these slips, leave a little above the mouth of the case not pasted; then prime the case with meal powder, and twist the paper to a point.

Of a Projected Regulated Piece of Nine Mutations.

A regulated piece, if well executed, is as curious a work as any in fireworks; for it consists of fixed and moveable pieces on one spindle, representing various sorts of figures, which take fire successively one from another, without any assistance after lighting the first mutation; but, for the better explanation of this piece, I shall give a full description of the method of communicating the fire from one mutation to the other, with a figure of each as they stand on the spindle. Regulated pieces are made of many sorts, and of any number of mutations, from two to nine, which is the greatest number I ever knew a piece to consist of, except one of my own making, which was composed of fifteen mutations,

mutations, all different fires, and figures. But, as an explanation of so large a piece, would be very difficult, to comprehend, I shall omit it, leaving so many changes to those who have made a great progress in this art, and only teach the manner of making a piece of nine mutations, as shewn in Plate V, fig. 53. As it will be necessary that every mutation should be separately explained, I will first give the name of each, with the colour of fire, and size of the case belonging to it: after which shall proceed, with the proportion of each mutation, together with the nature of the spindle, and manner of placing the leaders

First Mutation

Is a hexagon vertical wheel, illuminated in front with small port fires tied on the spokes; this wheel must be cloathed with two ounce cases, filled with black charge; the length of these cases, are determined by the size of the wheel, but must burn singly.

Second

Second Mutation

Is a fixed piece called a golden glory, by reason of the cases being filled with spur-fire; the cases must stand perpendicular to the block on which they are fixed, so that, when they are burning, they may represent a glory of fire; this mutation is generally composed of five, or seven two ounce cases.

Third Mutation

Is moveable, and is nothing more than an octagon vertical wheel, cloathed with four ounce cases, filled with brilliant charge; two of these cases must burn at a time: in this wheel you may make changes of fire.

Fourth Mutation

Is a fixed sun of brilliant fire, consisting of twelve four ounce cases; the necks of these cases must be a little larger than those of four ounce wheel cases; in this mutation may be made a change of fire,
by

by filling the cafes half with brilliant charge and half with grey.

Fifth Mutation

Is a fixed piece called the porcupine's quills; this piece consists of twelve spokes, standing perpendicular to the block in which they are fixed; on each of these spokes, near the end, must be placed a four ounce case of brilliant fire; all these cafes must incline either to the right or left, so that they may all play one way.

Sixth Mutation

Is a standing piece called the cross fire. This mutation consists of eight spokes fixed in a block; near the end of each of those spokes, must be tied two four ounce cafes of white charge, one across the other, so that the fires from the cafes on one spoke, may intersect the fire from cafes on the other.

Seventh Mutation

Is a fixed wheel, with two circular fells, on which are placed sixteen eight ounce

ounce cases of brilliant fire, in the form of a star: this piece is called a fixed star of wild fire.

Eighth Mutation.

This is a beautiful piece, called a brilliant star piece, it consists of six spokes, which are strengthened by two fells of a hexagon form at some distance from each other; at the end of each spoke, in the front, is fixed a brilliant star of five points; and on each side of every star is placed a four ounce case of black or grey charge; these cases must be placed with their mouths side ways, so that their fires may cross each other.

Ninth Mutation

Is a wheel piece; this is composed of six long spokes, with a hexagon vertical wheel at the end of each; these wheels run on spindles in the front of the spokes; all the wheels are lighted together: two ounce cases will do for these wheels, and may be filled with any coloured charge.

Q

After

After having spoke of the several parts of the regulated piece, each by their proper names and colour of fire, I shall next proceed with the proportion of every mutation, together with the method of conveying the fire from one to the other, and the distance they stand one from the other on the spindle.

First Mutation

Must be a hexagon vertical wheel, fourteen inches diameter; on one side of the block, whose diameter is two inches and a quarter, is fixed a tin barrel A, see fig. 53, N^o. 1; this barrel must be a little less in diameter than the nave; let the length of the barrel and block be six inches. Having fixed the cases on the wheel, carry a leader from the tail of the last case into the tin barrel through a hole made on purpose two inches from the block; at the end of this leader let there be about an inch or two of loose match, but take care to well secure the hole wherein the pipe is put, to prevent any sparks falling in, which would light the second mutation before its time, and confuse the whole piece.

Second

Second Mutation

Is thus made. Have a nave turned two inches and a half diameter, and three long; then let half an inch of that end which faces the first wheel be turned so as to fit easy into the tin barrel of the first mutation, which must turn round it without touching; on the other end of the block, fix a tin barrel B, N^o. 2, this barrel must be six inches in length, and only half an inch of it to fit on the block. Round the nave fix five spokes, one inch and a half in length each; the diameter of the spokes must be equal to a two ounce former; on these spokes put five seven inch two ounce cases of spur fire, and carry leaders from the mouth of one to the other, that they may all light together; then from the mouth of one of the cases, carry a leader, through a hole bored slantways in the nave, from between the spokes, to the front of the block near the spindle hole; the end of this leader must project out of the hole into the barrel of the first mutation, so that when the pipe which comes from the end of the last case on the first wheel flashes,

Q₂

it

it may take fire and light the second mutation. To communicate the fire to the third mutation bore a hole near the bottom of one of the five cases, to the composition, and from thence carry a leader into a hole made in the middle of the barrel B; this hole must be covered with pasted paper.

Third Mutation

May be either an octagon or hexagon wheel twenty inches diameter; let the nave be three inches and a quarter diameter, and three and a half in length; one inch and a half of the front of the nave must be made to fit in the barrel B. On the other end of the block fix a tin barrel C, N^o. 3; this barrel must be six inches and a half in length, one inch of which must fit over the block. The cases of this wheel must burn two at a time; and from the mouths of the two first cases carry a leader, through holes in the nave into the barrel of the second mutation, after the usual manner; but besides these leaders let there be a pipe go across the wheel from one first case to the other, then from the tail of one of the last cases, carry a pipe into a hole
in

in the middle of the barrel C; at the end of this pipe, let there hang some loose quick match.

Fourth and Fifth Mutation.

We shall here speak of those two mutations under one head, as their naves are made of one piece, which from E to F is fourteen inches; E, a block four inches diameter, with ten or twelve short spokes, on which are fixed eleven inch eight ounce cases; let the front of this block be made to fit easy in the barrel C, and cloath the cases so that they may all light together; and let a pipe be carried through a hole in the block into the barrel C, in order to receive the fire from the leader brought from the last case on the wheel. G, the nave of the fifth mutation, whose diameter must be four inches and a half; in this nave fix ten or twelve spokes one foot and a half in length each; these spokes must stand seven inches distance from the spokes of the fourth mutation; and at the end of each spoke tie a four ounce case, as shewn by N°. 5; all these cases are to be lighted together, by a leader brought from the end of one of

the cafes on N^o. 4. Let F and H be of the same piece of wood as E and G; but as much thinner as possible, in order to make the work light.

Sixth and Seventh Mutation.

The blocks of these two mutations, are turned out of one piece of wood, whose length from F to P is fifteen inches. L a block five inches diameter, in which are fixed eight spokes, each two feet four inches in length; at the end of each spoke tie two four ounce cafes as shewn by N^o. 6; all these cafes must be fired at the same time, by a pipe brought from the end of one of the cafes on the fifth mutation. Let the distance between the spokes at L and those in the fifth mutation be seven inches. M, the nave of the seventh mutation, whose diameter must be five inches and a half; in this nave fix eight spokes, and on the front of them two circular fells, one of four feet eight diameter, and one of three feet eleven inches diameter; on these fells, tie sixteen eight ounce or pound cafes, in the same manner as represented by N^o. 7,
and

and carry leaders from one to the other, so that they may be all fired together; this mutation must be fired by a leader brought from the tail of one of the cases on the sixth mutation.

Eighth and Ninth Mutation.

The blocks of these may be turned out of one piece, whose length from P to D must be twelve inches. O, the block of the eighth mutation, which must be six inches diameter, and in it fixed six spokes, each three feet in length; these spokes must be strengthened by a hexagon fell within three or four inches of the ends of the spokes; close to the end of each spoke, in the front, fix a five-pointed brilliant star; then seven inches below each star tie two ten inch eight ounce cases, so that the upper ends of the cases may rest on the fells, and their ends on the spokes; each of these cases must be placed parallel to the opposite fell, see N^o. 8. NNN, &c. are the cases, and kkk, &c. the stars.

The ninth mutation must be thus made; let D be a block seven inches diameter; in this block must be screwed

Q₄

fix

fix spokes, six feet in length each, with holes and grooves in them for leaders, in the same manner as those in the dodecaedron; at the end of each spoke, in the front, fix a spindle for a hexagon vertical wheel, ten inches diameter, as shewn by N^o. 9. When these wheels are on, carry a leader from each into the block, so that they may all meet together; then lead a pipe from the end of one of the cases of the eighth mutation, through a hole bored in the block D, to meet the leaders from the vertical wheels, so that they may all be fired together.

The spindles for large pieces are required to be made very strong, and as exact as possible; for a piece of nine mutations, let the spindle be at the large end one inch diameter, and continue that thickness as far as the seventh mutation, and from thence to the fifth; let its diameter be three quarters of an inch; from the fifth to the fourth, five eighths of an inch; from the fourth to the second, half an inch; and from the second to the end, three eighths of an inch: at the small end must be a nut to keep on the first wheel, and at the thick end must be a large nut, as shewn
by

by the figure, so that the screw part of the spindle being put through a post, and a nut screwed on tight, the spindle will be held fast and steady; but you are to observe, that that part of the spindle, on which the moveable pieces are to run, be made long enough for the wheels to run easy without sticking; the fixed pieces being made on different blocks, the leaders must be joined, after they are fixed on the spindle. The best method of preventing the fixed mutations from moving on the spindle, is, to make that part of the spindle which goes through them square; but as it would be difficult to make square holes through such long blocks as are sometimes required, it will be best to make them in the following manner; which is, to bore a round hole a little larger than the diameter of the spindle, and at each end of the block over the hole, fasten a piece of brass with a square hole in it to fit the spindle.

To make a Horizontal Wheel
change to a Vertical Wheel with
a Sun in Front.

The sudden change of this piece is very pleasing, and gives great surprize to those who are not acquainted with the contrivance. A wheel for this purpose should be about three feet diameter, and its fell circular, on which tie sixteen half pound cases filled with brilliant charge; two of these cases must burn at a time, and on each end of the nave must be a tin barrel of the same construction as those on the regulated piece; the wheel being compleated, prepare the post or stand after the following manner: first have a stand made of any height, about three or four inches square, then saw off from the top, a piece two feet in length; this piece join again at the place where it was cut, with a hinge on one side, so that it may lift up and down in the front of the stand, then fix on the top of the bottom part of the stand, on each side a bracket; these brackets must project at right angles with the stand, one foot

foot from the front, for the short piece to rest on; but these brackets must be placed a little above the joint of the post, so that when the upper stand falls, it may lay between them at right angles with the bottom stand, which may be done by fixing a piece of wood, one foot in length, between the brackets and even with the top of the bottom stand; then, as the brackets rise above the bottom stand, they will form a channel for the short post to lay in, and at the same time keep it steady without straining the hinge: on the side of the short post opposite the hinge, nail a piece of wood; this piece must be of such a length, that, when the post is perpendicular, it may reach about one foot and a half down the long post, to which being tied, it will hold the short stand upright; the stand being thus prepared, in the top of it fix a spindle ten inches in length; on this spindle put the wheel, then fix on a brilliant sun with a single glory; the diameter of this sun must be six inches less than that of the wheel. When you fire this piece, light the wheel first, and let it run horizontally till four cases are consumed; then from the end of the fourth case carry a leader
into

into the ten barrel that turns over the end of the stand; this leader must be met by another brought through the top of the post, from a case filled with a strong port-fire charge, and tied to the bottom post, with its mouth facing the pack-thread which holds up the stand, so that when this case is lighted, it will burn the pack-thread, and let the wheel fall forward, by which means it will become vertical; then from the last case of the wheel, carry a leader into the barrel next the sun, which will begin as soon as the wheel is burnt out.

Of the grand Volute illuminated
with a projected Wheel in
Front.

First have two hoops made of strong iron wire, one of six feet diameter, and one of four feet two inches; these hoops must be joined to scroles A, A, A, &c. as shewn by fig. 54. These scroles must be made of the same sort of wire as the hoops; on these scroles, tie with iron binding wire as many illuminating port fires as they will hold, at two inches distance from each other; these port
fires

ARTIFICIAL FIREWORKS. 237

fires cloath with leaders, so that they may all take fire together; then let C be a circular wheel of four spokes, three feet six inches diameter, and on its fell tie as many four ounce cases head to tail, as will compleat the circle, only allowing a sufficient distance between the cases, that the fire may pass free, which may be done by cutting the upper part of the end of each case a little shelving: on each spoke fix a four ounce case about three inches from the fell of the wheel; these cases are to burn one at a time, and the first of them to begin with those on the fell, of which four are to burn at a time, so that the wheel will last no longer than one fourth of the cases on the fell, which in number should be sixteen or twenty; on the front of the wheel form a spiral line, with strong wire, on which tie port fires, placing them on a slant, with their mouths to face the same way as the cases on the wheel; all these port fires must be fired with the second cases of wheel. Let D, D, D, &c. be spokes of wood, all made to screw into a block in the center; each of these spokes may be in length about four feet six inches; in the top of each fix a spindle, and on each spindle

spindle put a spirali wheel of eight spokes, such as are represented by E, E, E, &c. The blocks of these wheels must have a hole at top for the center cases, and the spindle must have nuts screwed on their ends, which nuts should fit in the holes at top of the blocks, so that all the wheels, must be put on before you fix in the center cases: as some of these wheels by reason of their situation will not bear on the nut, it will be necessary to have smooth shoulders made on the spindles for the blocks to run on; the cases of these wheels are to burn double, and the method of firing them is, by carrying a leader from each down the spokes into the block in the center, in the same manner as those in the dodecaedron, but the center case of each wheel, must begin with the two last cases as usual; it is to be observed, that the large circular wheel in front must have a tin barrel on its block, into which a pipe must be carried, from one of the second cases on the wheel; this pipe being met by another from the large block, in which the eight spokes are screwed, will fire all the spirali wheels and the illuminating port fires at the same time. The cases of the projected wheel,

wheel may be filled with a white charge, and those of the spirali wheels, with a grey.

Of the Moon and Seven Stars.

Let fig. 55, be a smooth circular board, six feet diameter; out of the middle of it cut a circular piece twelve or fourteen inches diameter, and over the vacancy put white Persian silk, on which paint a moon's face, then let I, I, I, &c. be stars each four or five inches diameter, cut out with five points, and covered with oiled silk: on the front of the large circular board, draw a seven-pointed star, as large as the circle will allow; then on the lines which form this star, bore holes, wherein fix pointed stars. When this piece is to be fired, it must be fixed upon the front of a post, on a spindle, with a wheel of brilliant fire behind the face of the moon; so that while the wheel burns, the moon and stars will appear transparent, and when the wheel has burnt out, they will disappear, and the large star in front, which is formed of pointed stars, will begin, being lighted by

by a pipe of communication from the last case of the vertical wheel, behind the moon; this pipe of communication must be managed in the same manner as those in regulated pieces.

Of the Double Cone Wheel illuminated.

This piece is represented by fig 56. Let A, be a strong decagon wheel, two feet six inches diameter; then on each side of it fix a cone B and C; these cones are to consist of a number of hoops, supported by three or four pieces of wood, in the manner of the spiral wheels; let the height of each cone be three feet six inches, and on all the hoops tie port fires horizontally, with their mouths outwards, and cloath the wheel with eight ounce cases, all to play horizontally, two at a time: the cones may be fired with the first or second cases. The spindle for this piece must go through both the cones, and rise three feet above the point of the cone at top, so that its length will be ten feet four inches from the top of the post H, in which it is fixed, allowing
four

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four inches for the thickness of the block of the wheel; the whole weight of the wheel and cones must bear on a shoulder in the spindle, on which the block of the wheel must turn; near the top of the spindle, must be a hole in the front, into which screw a small spindle, after the cones are on; then on this small spindle fix a sun D, composed of sixteen nine inch four ounce cases of brilliant fire, which cases must not be placed on a fell, but only stuck into a block of six inches diameter; then in the front of this sun must be a circular vertical wheel, sixteen inches diameter; on the front of this wheel form with iron wire a spiral line, and cloath it with illuminations, after the usual method; as this wheel is not to be fired till the cones are burnt out, the method of firing it is as follows; let the hole in the block, at the top of the uppermost cone, be a little larger than the spindle which passes through it; then from the first case of the vertical wheel before the sun, carry a leader down the side of the spindle to the top of the block of the horizontal wheel, on which must be a tin barrel; then this leader, being met by another brought from the end of the

R
last

last case of the horizontal wheel, will give fire to the vertical wheel, as soon as the cones are extinguished; but the gun D must not be fired, till the vertical wheel is quite burnt out.

Of Fire Pumps.

Cases for fire pumps, are made in the same manner as those for tourbillons, only they are pasted instead of being rolled dry. Having rolled and dried your cases, fill them in the following manner: first put in a little meal powder, and then a star, on which ram lightly a ladle or two of composition, then a little meal powder, and on that a star, then again composition, and so on till you have filled the case. Stars for fire pumps should not be round, but must be made either square, or flat and circular, with a hole through the middle; the quantity of powder for throwing the stars must increase as you come near the top of the case, for if much powder be put at the bottom, it will burst the case. The stars must differ in size, in this manner; let the star which you put in first, be about one fourth less than the bore
of

of the case, but let the next star be a little larger, and the third star a little larger than the second, and so on; let them increase in diameter, till within two of the top of the case, which two must fit in tight. As the loading of fire pumps is somewhat difficult, it will be necessary to make two or three trials, before you depend on their performance: when you fill a number of pumps, take care not to put in each an equal quantity of charge between the stars, so that when they are fired they may not throw up too many stars together. Cases for fire pumps should be made very strong, and rolled on four or eight ounce formers, ten or twelve inches in length each.

Of the Vertical Scrole Wheel.

This wheel may be made of any diameter, but must be constructed as shewn by fig. 57, to do which proceed thus; have a block made of a moderate size, into which fix four flat spokes, and on them fix a flat circular fell of wood; round the front of this fell place port-fires; then on the front of the spokes

R 2

form.

form a scrole, either with a hoop or strong iron wire; on this scrole tie cases of brilliant fire, in proportion to the wheel, head to tail, as in the figure; when you fire this wheel, light the first case near the fell; then, as the cases fire successively, you will see the circle of fire gradually diminish; but whether the illuminations on the fell begin with the scrole or not, is immaterial, that being left intirely to the maker.

N. B. This wheel may be put in the front of a regulated piece, or fired by itself, occasionally.

Of Pin Wheels.

First roll some paper pipes, about fourteen inches in length each; these pipes must not be made thick of paper, two or three rounds of elephant paper being sufficient; when your pipes are thoroughly dryed, you must have made a tin tube, twelve inches in length, to fit easy into the pipes; at one end of this tube fix a small conical cup, which being done, it is called a funnel, then bend one end of one of the pipes, and put the funnel in at the other, as far as it will reach,

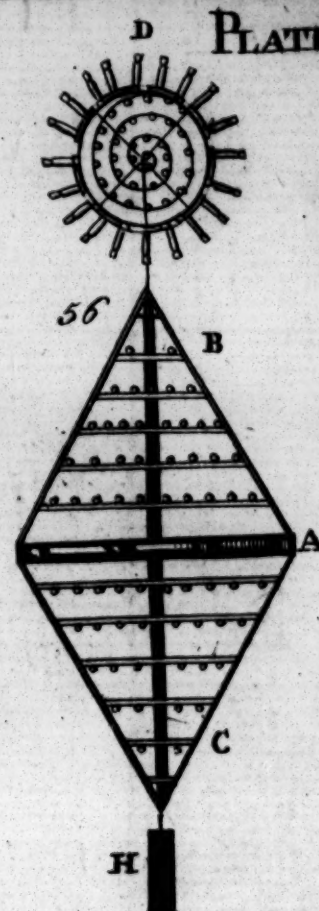
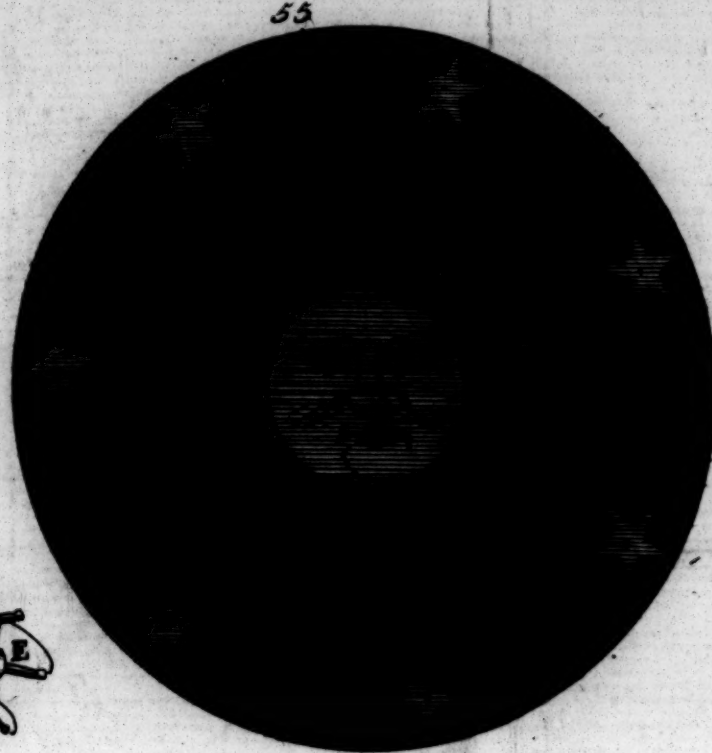
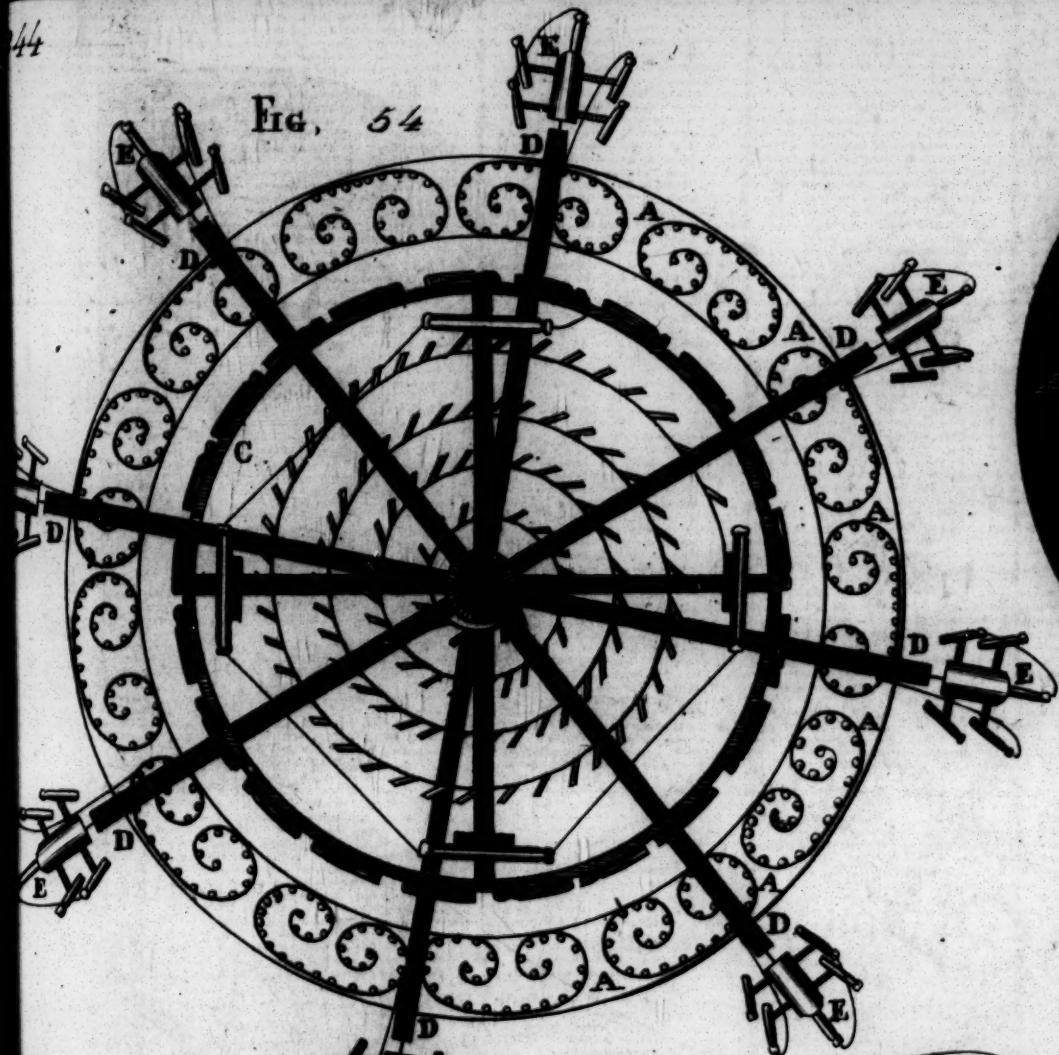
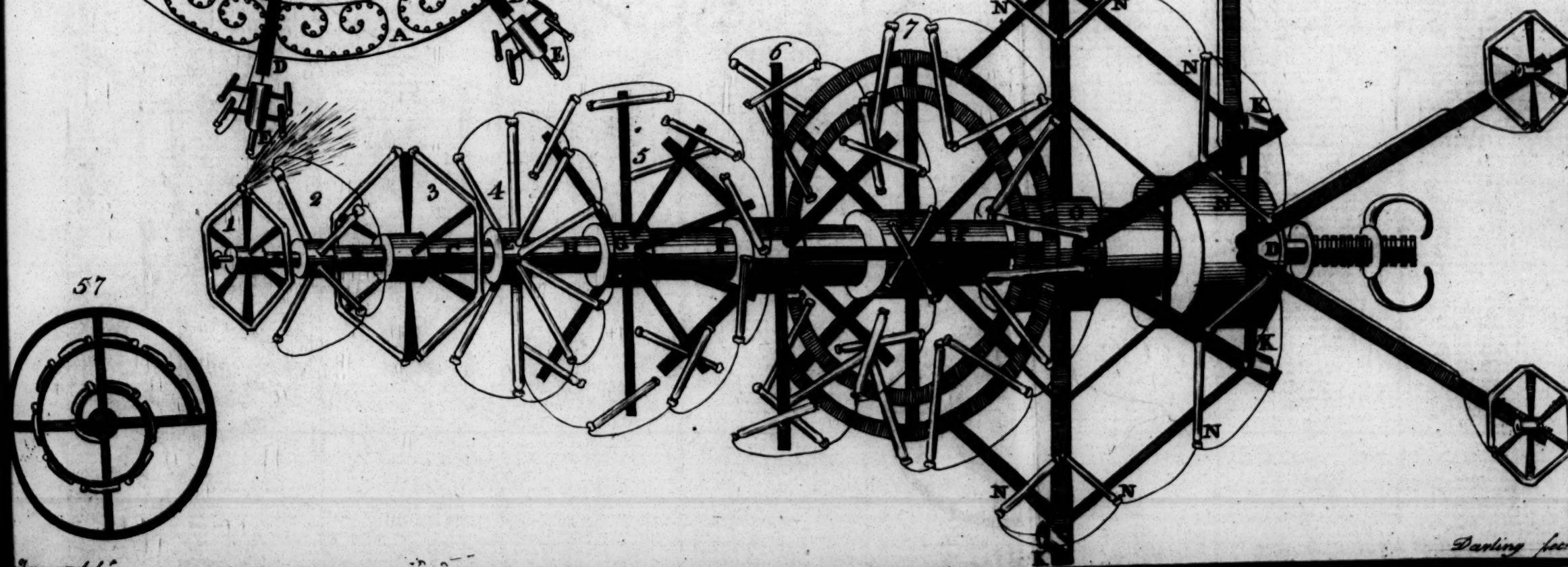
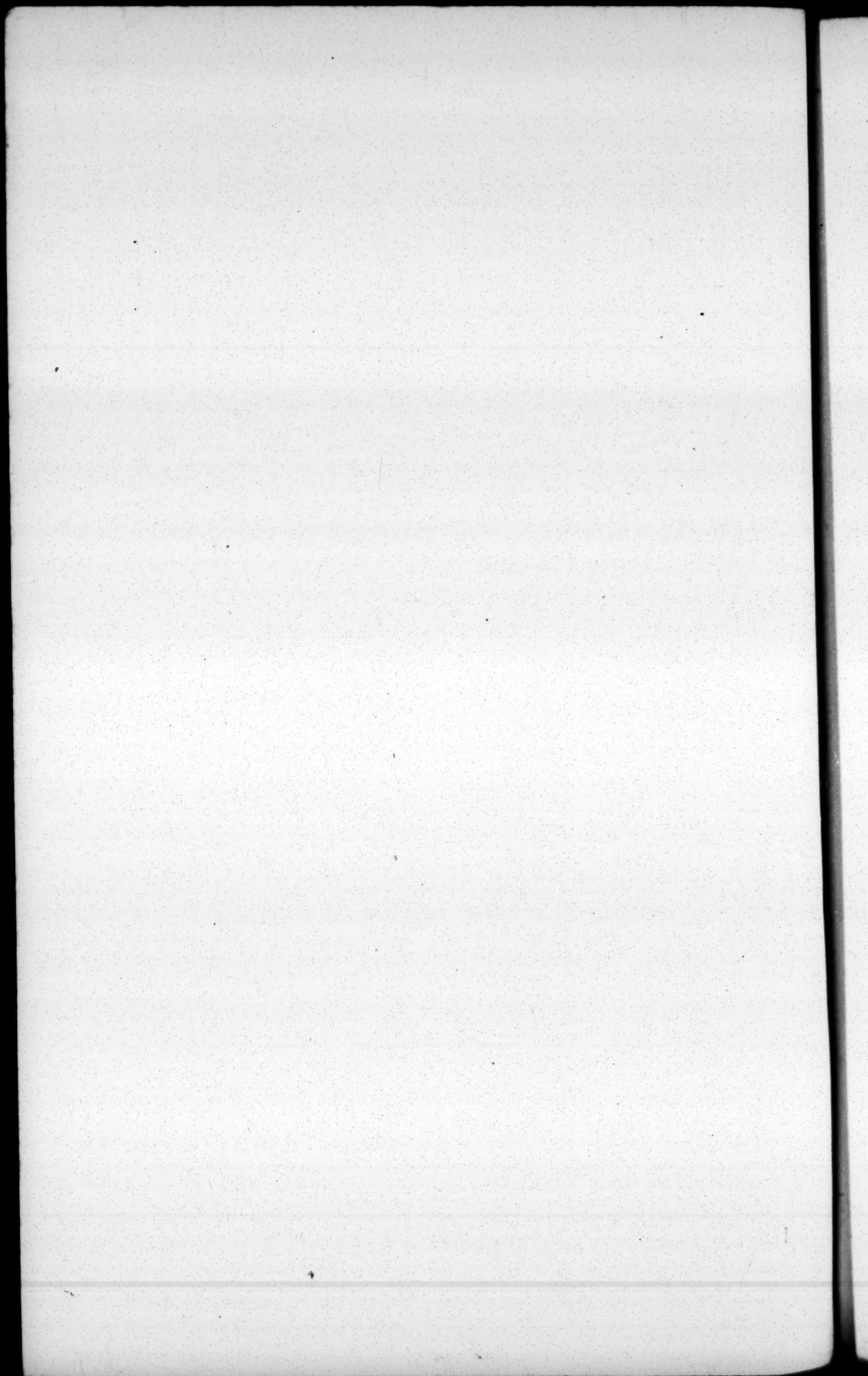


Fig. 53





reach, and fill the cup with composition; then draw out the funnel by a little at a time, shaking it up and down, and it will fill the pipe as it comes out; having filled some pipes, have made some small blocks, about an inch diameter, and half an inch in thickness; round one of these blocks wind and paste a pipe, and to the end of this pipe join another, which must be done by twisting the end of one pipe to a point, and putting it into the end of the other, with a little paste; in this manner join four or five pipes, winding them one upon the other, so as to form a spiral line; having wound on your pipes, paste two slips of paper across them, to hold them together; besides these slips of paper, the pipes must be pasted together.

There is another method of making these wheels, called the French method; which is, by winding on the pipes without paste, and sticking them together with sealing wax, at every half turn; so that when they are fired, the end will fall loose every time the fire passes the wax, by which means the circle of fire will be considerably increased. The formers for these pipes are made from one and a half to four sixteenths of an

R 3 inch

inch diameter, and the composition for them as follows; meal powder eight ounces, salt petre two ounces, and sulphur one; among these ingredients, may be mixed a little steel-filings, or the dust of cast-iron; this composition should be very dry, and not made too fine, or it will stick in the funnel. These wheels may be fired on a large pin, and held in the hand with safety.

Of Fire Globes.

There are two sorts of fire globes, one with projected cases, and the other with the cases concealed in the following manner; have a globe made of wood, of any diameter you chuse, and divide the surface of it into fourteen equal parts, and at each division bore a hole perpendicular to the center; these holes must be in proportion to the cases intended to be used; in every hole, except one, put a case filled with brilliant, or any other charge, and let the mouths of the cases be even with the surface of the globe; then cut in the globe a groove, from the mouth of one case to the other, for leaders, which must be carried from
case

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case to case, so that they may all be fired together; this being done, cover the globe with a single paper, and paint it. These sort of globes may be used to ornament a building.

Fire-globes with projected cases are made thus; your globe being made with fourteen holes bored in it as usual, fix in every hole, except one, a case, and let each case project from the globe two thirds of its length; then cloath all the cases with leaders, so that they may all take fire at the same time. Fire-globes are supported by a pintle, made to fit the hole in which there is no case.

To thread and join Leaders, with the method of placing them on different Works.

Joining and placing of Leaders is a very essential part of fireworks, as it is on the leaders, that the performance of all complex works depend; for which reason I shall endeavour here to explain the method of conducting pipes of communication, in as plain a manner as possible. Your works being ready to be cloathed, proceed thus; cut your pipes

R 4 of

of a sufficient length to reach from one case to the other, then put in the quick match, which must always be made to go in very easy; when the match is in, cut it off within about an inch of the end of the pipe, and let it project as much at the other end; then fasten the pipe to the mouth of each case with a pin, and put the loose ends of the match into the mouths of the cases, with a little meal powder; this being done to all the cases, paste over the mouth of each two or three bits of paper; the preceding method is used for large cases, and the following for small cases and illuminations; first thread a long pipe, then lay it on the tops of the cases, and cut a bit off the under side, exactly over the mouth of each case, so that the match may appear; then pin the pipe to every other case, but before you put on the pipes, put a little meal powder in the mouth of each case; if the cases thus cloathed be port-fires on illuminated works, cover the mouth of each case with a single paper; but if they are choaked cases, situated so that a number of sparks from other works may fall on them before they are fired, secure them with
three

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three or four papers, which must be pasted on very smooth, that there may be no creases for the sparks to lodge in, which often set fire to the works before their time; avoid, as much as possible, placing the leaders too near together, or one across the other so as to touch, as it sometimes happens that the flash of one will fire the other; therefore if your works should be so formed, that the leaders must cross or touch, be sure to make them very strong, and secure them well at the joints and at every opening.

When a great length of pipe is required, it must be made by joining several pipes together, in this manner; having put on one length of match as many pipes as it will hold, paste paper over every joint; but if a still greater length be required, more pipes must be joined, by cutting off about an inch of one side of each pipe near the end, and laying the quick match together, and tying them fast with small twine; after which, cover the joining with pasted paper.

The

The manner of placing Fireworks
to be exhibited, with the order
of Firing.

Nothing adds more to the appearance of fireworks, than the placing them properly; though the manner of placing them chiefly depends on the judgment of the maker. I shall give such rules here, as have been generally observed; for example, whether your works are to be fired on a building, or on stands; if they are a double set, place one wheel of a sort on each side of the building, and next to each of them towards the center, place a fixed piece, then wheels, and so on, leaving a sufficient distance between them, for the fire to play from one without burning the other; having fixed some of your works thus in front, place the rest behind them, in the center of their intervals; the largest piece, which is generally a regulated or transparent piece, must be placed in the center of the building, and behind it a gun, which must always stand above all the other works: a little
2 before

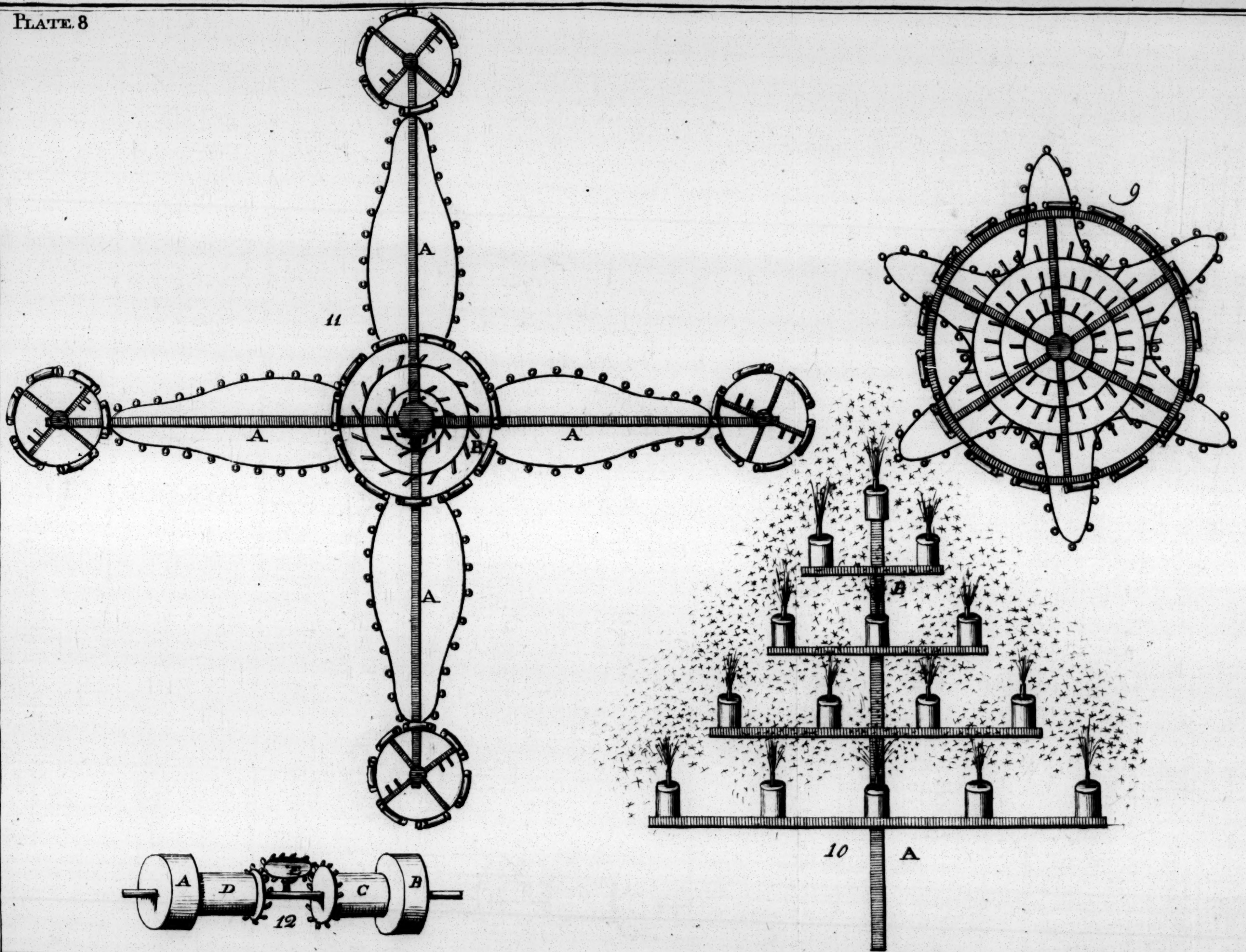
before the building or stands place your large gerbes, and at the back of the works, fix your marron batteries, pots des aigrettes, pots des brins, pots des fauciffons, air ballóons, and flights of rockets; the rocket stands may be fixed behind or any where else, so as not to be in the way of the works.

Single collections are fired on stands, which stands are made in the same manner as theodolite stands, only the top part must be long or short occasionally; these sort of stands may be fixed up very soon without much trouble. Having given sufficient instructions for placing of fireworks, I shall proceed with the manner of firing them.

Order

Order of Firing.

1. Two signal rockets,
2. Six sky rockets,
3. Two honorary rockets,
4. Four caduceus rockets,
5. Two vertical wheels illuminated,
6. Two spiral wheels illuminated,
7. Two transparent stars,
8. A line rocket of five changes,
9. Four tourbillons,
10. Two horizontal wheels,
11. Two air ballóons illuminated,
12. Two Chinese fountains,
13. Two regulating pieces of four mutations each,
14. Two pots des aigrettes,
15. Three large gerbes,
16. A flight of rockets,
17. Two ballóon wheels,
18. Two cascades of brilliant fire,
19. Twelve sky rockets,
20. Two illuminated yew-trees,
21. Two air ballóons of serpents,
and two compound,
22. Four tourbillons,
23. Two



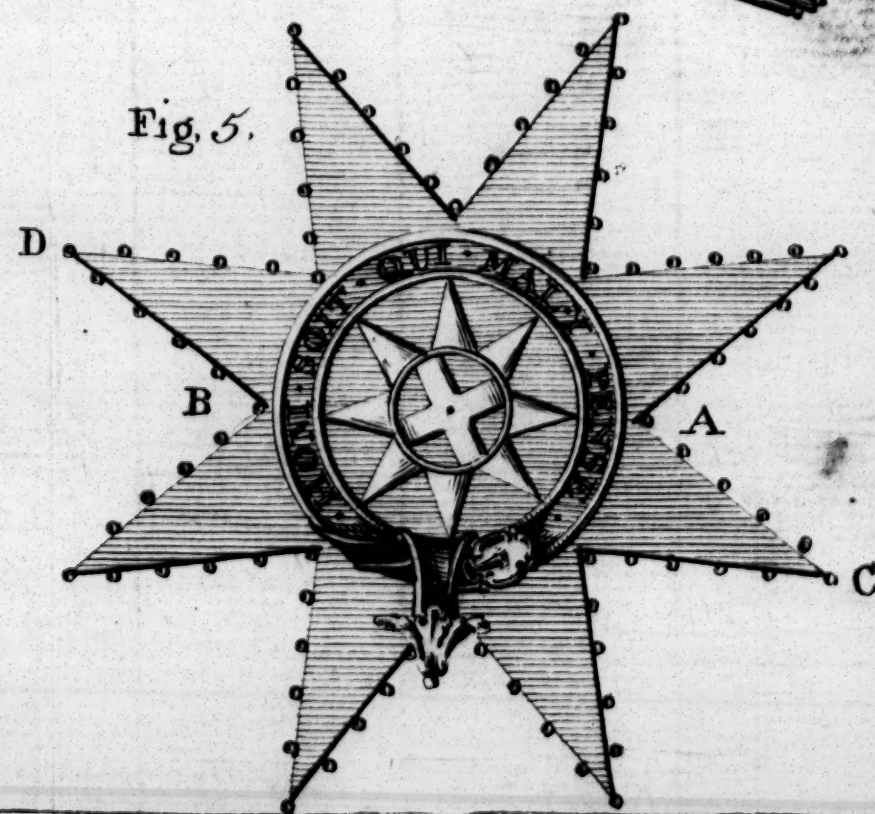
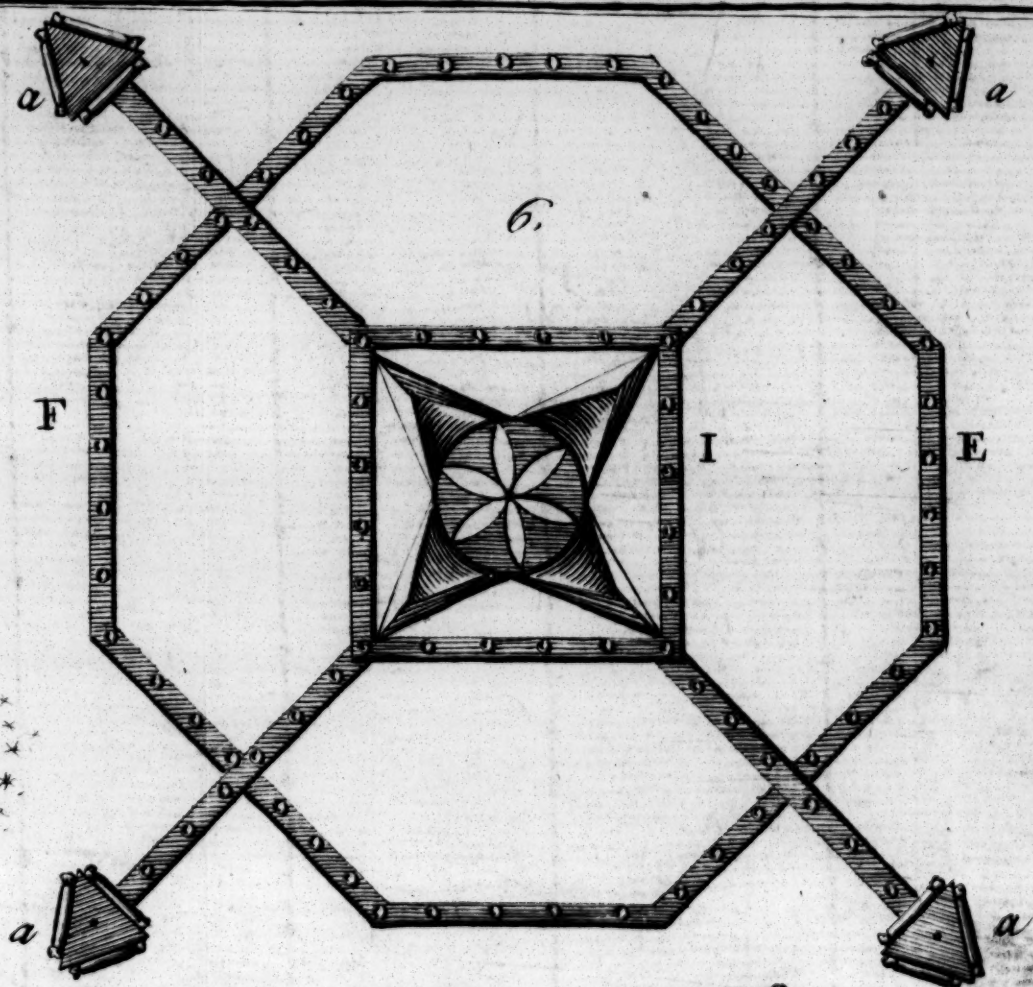
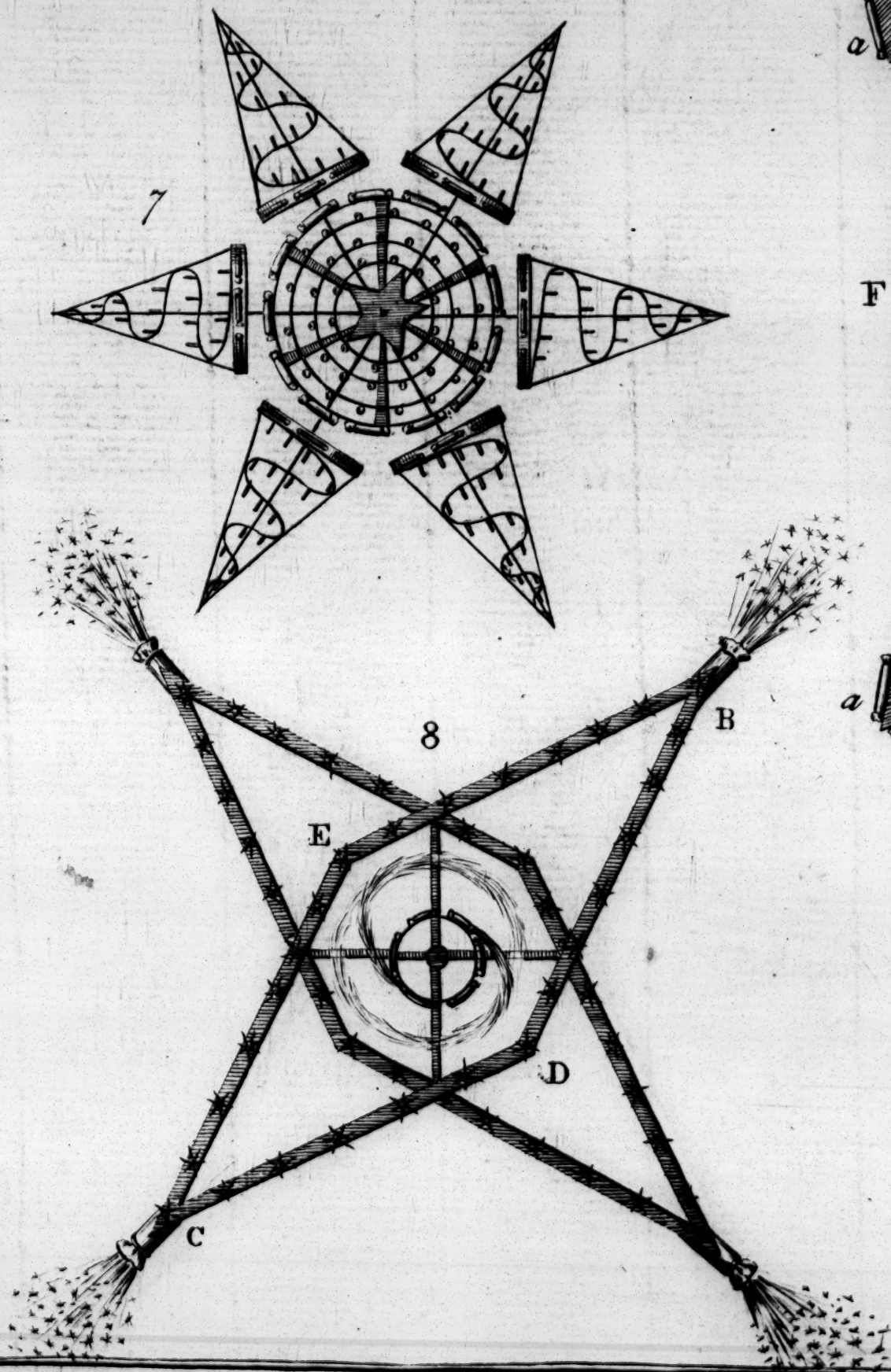
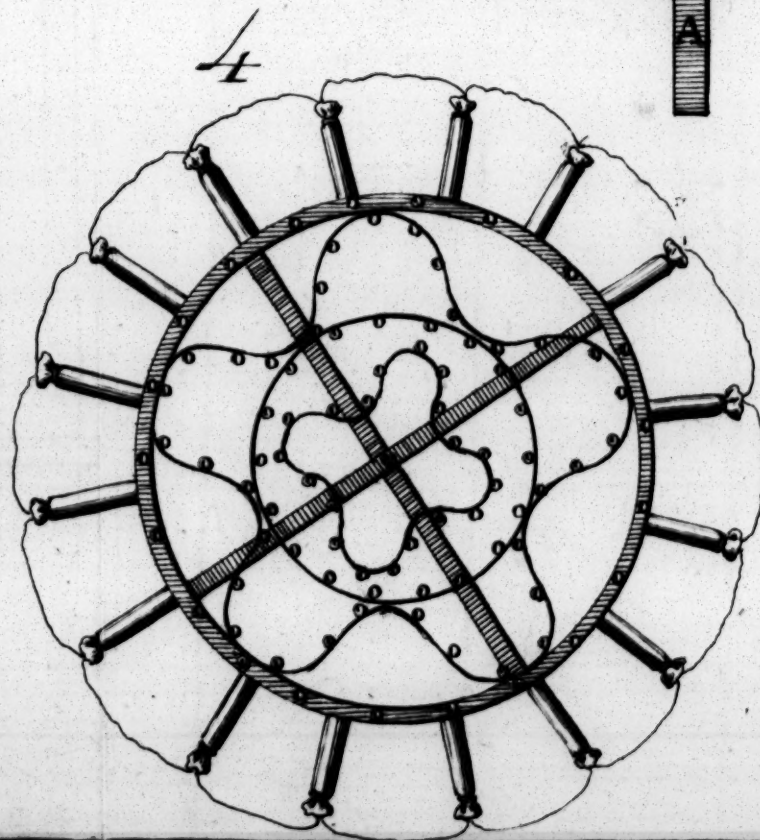
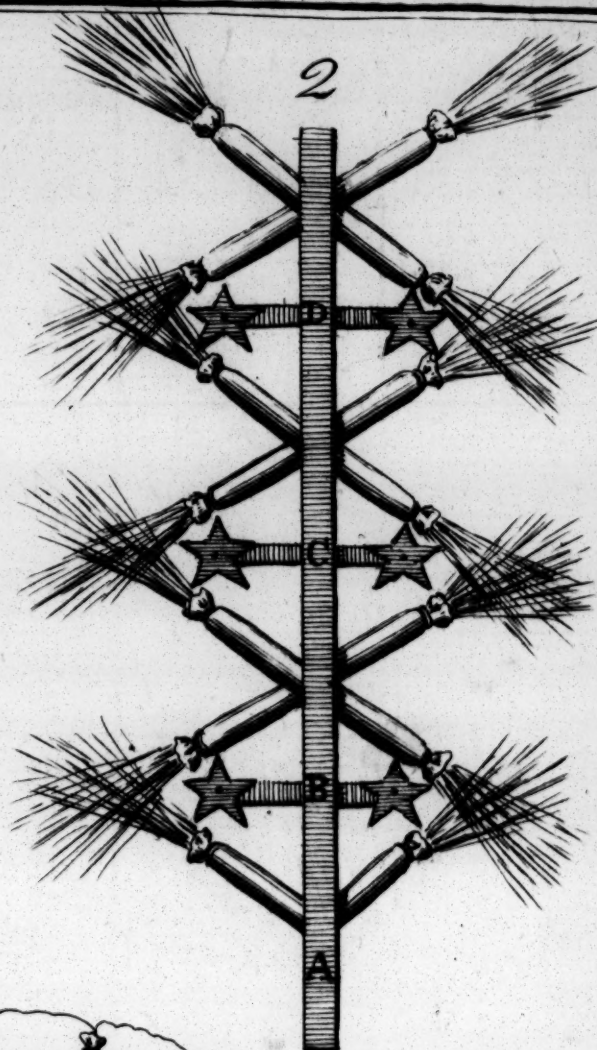
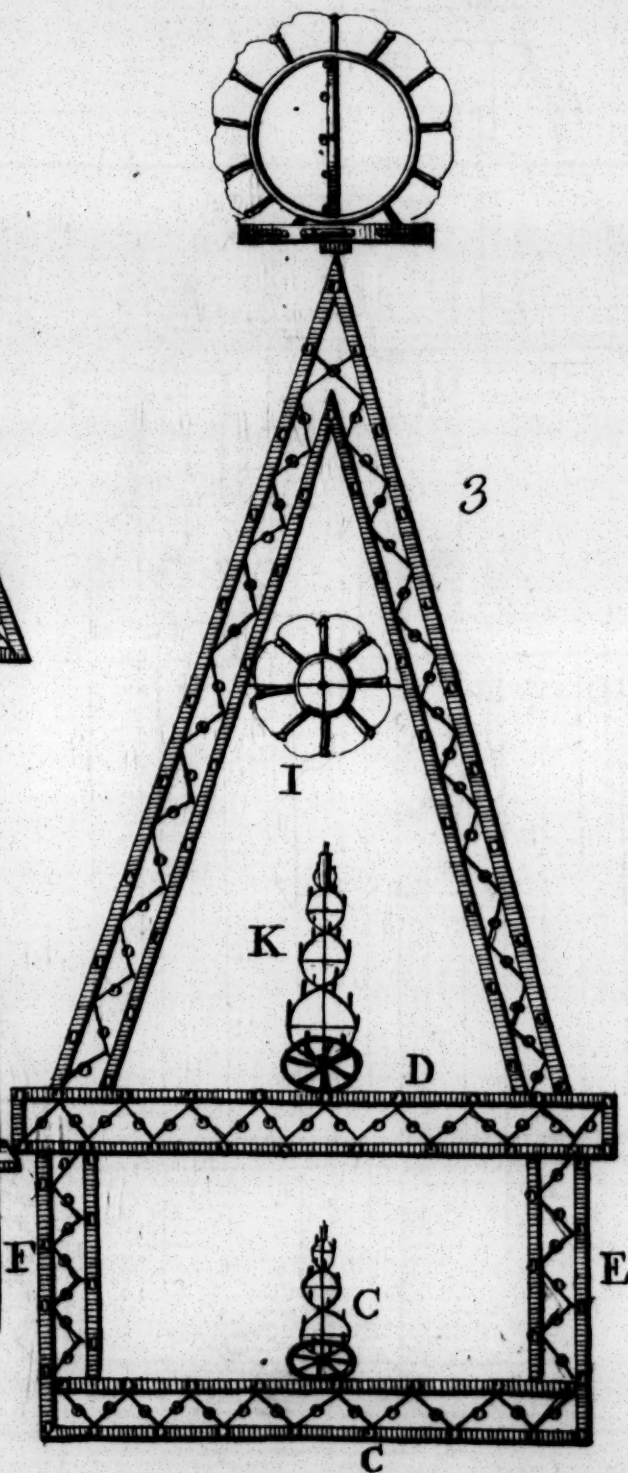
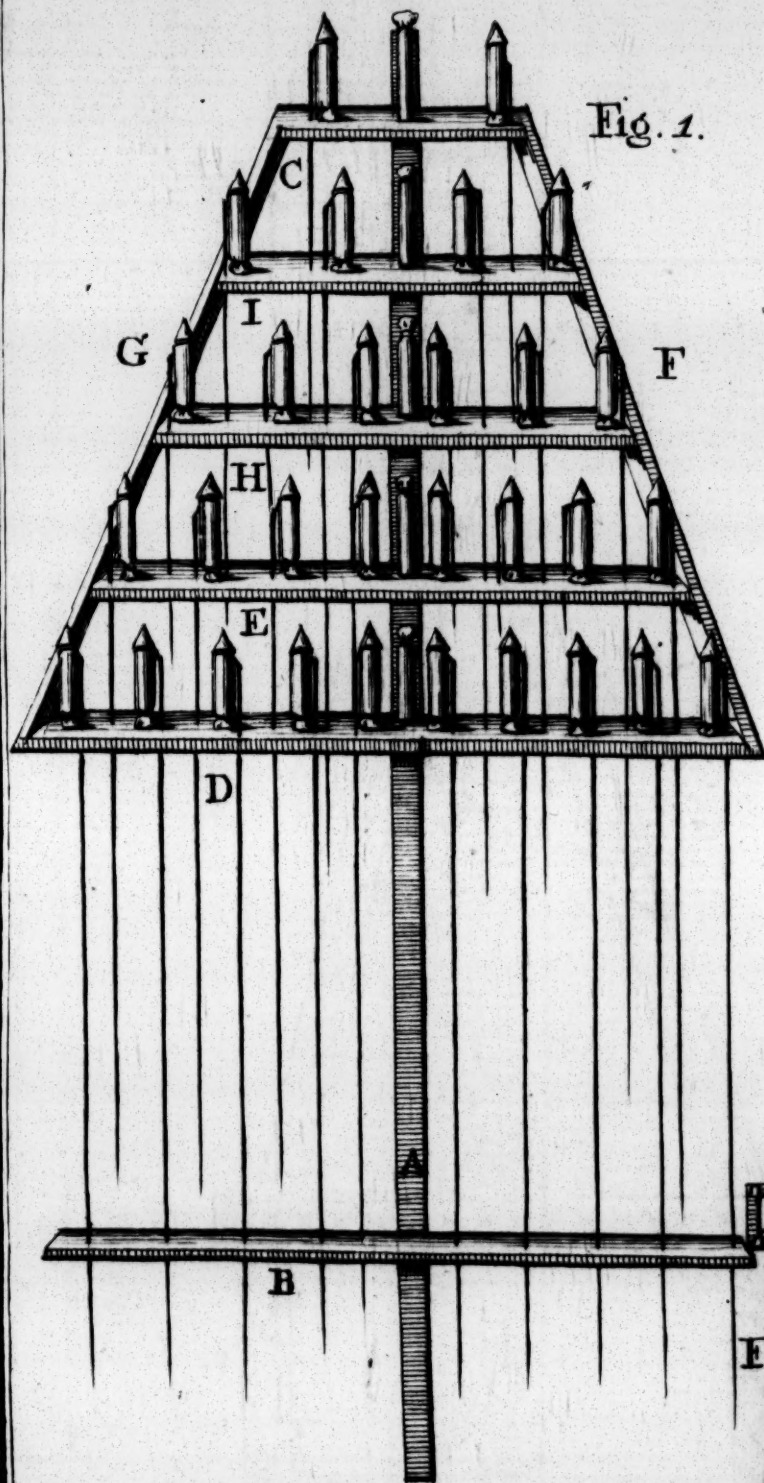
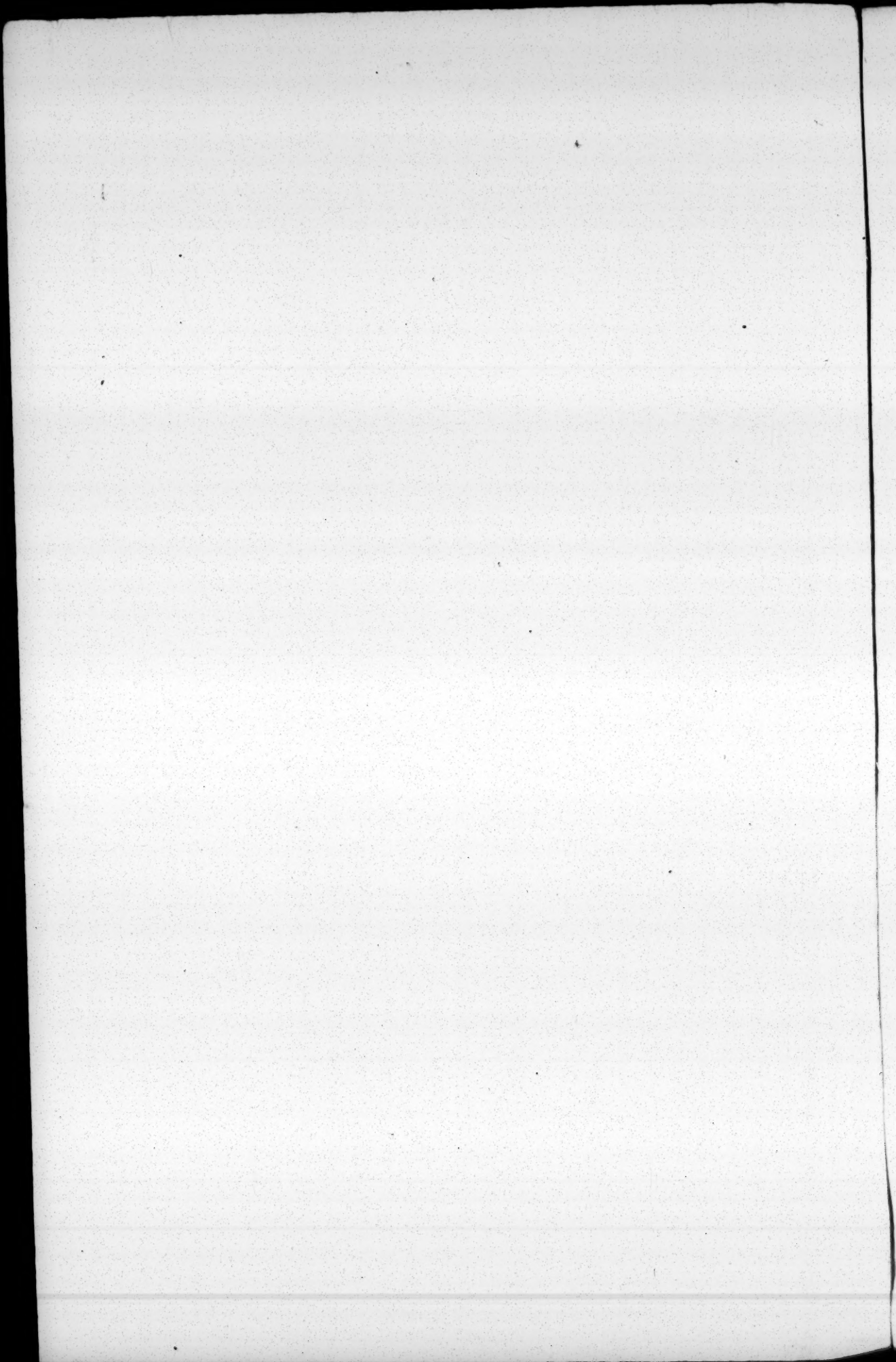


Fig. 1.





- 23 Two Fruiloni Wheels
- 24 Two Illuminated Globes with Horizontal Wheels
- 25 One Pot des Saucissons
- 26 Two Plural Wheels
- 27 A Marron Battery
- 28 Two Chandeliers Illuminated
- 29 A Range of Pots des Brins
- 30 Twelve Sky Rockets
- 31 Two Yew-Trees of Fire
- 32 A Nest of Serpents
- 33 Two Double Cones Illuminated
- 34 A Regulating Piece of Seven Mutations, viz.
 - 1 A Vertical Wheel Illuminated
 - 2 A Golden Glory
 - 3 An Octagon Vertical Wheel
 - 4 Porcupines Quills
 - 5 Cross Fires
 - 6 A Star Piece with Brilliant Rays
 - 7 Six Vertical Wheels
- 35 A Brilliant Sun
- 36 A Large Flight of Rockets

When water-works are to be exhibited, divide them into several sets, and fire one set after every fifth or sixth change of land and air-works; and observe this rule in firing in a double set of works, always to begin with sky-rockets, then two moveable pieces, then two fix'd pieces, and so on, ending with a large flight of rockets, or a marron battery; if a single collection, fire a fixed piece after every wheel or two, and now and then some air and water-works.

Fountain of Sky-Rockets.

Plate 6th. Fig. 1st, represents a fountain of thirty rockets; let A, be a perpendicular post, sixteen feet high from the ground, and four inches square. Let the rail or cross piece C, be one foot six inches in length,

length, three inches broad, and one thick. The rail D, at bottom, must be six feet in length, one foot broad, and an inch thick. F, and G, are the two sides which serve to supply the rails D, E, H, I, C; these sides are one foot broad at bottom, and cut in the front with a regular slope, to three inches at top, but their back edges must be parallel with the front of the pots A. The breadth of the rails E, H, I, will be determined by the breadth of the sides; all the rails must be fixed at two feet distance from each other, and at right angles with the pots; having placed the rails thus; bore in the bottom rail, ten holes at equal distances from each other, large enough to receive easily the stick of a one pound rocket; in the back edge of this rail cut a groove from one end to the other, fit to contain a quick-match, then cut a groove in the top of the rail, from the edge of each hole, into the groove in the back; in the same manner cut in the second rail E, eight holes and grooves; in the third rail H, six holes and grooves; in the fourth rail I, four holes and grooves; and in the top rail two holes and grooves; B, a rail with holes in it to guide the ends of the rocket sticks, this rail must be fixed six feet from the rail D; the fountain frame being thus made, prepare your rockets thus; tie round the mouth of each a piece of thin paper, large enough to go twice round, and to project about an inch and a half from the mouth of the rocket, which must be rubbed with wet meal-powder; in the mouth of each Rocket put a leader, which secure well with the paper that projects from the mouth of the case; these leaders must be carried into the grooves in the back of the rails, in which lay a quick-match from one end to the other, and cover it with pasted paper; holes must be made in the rail D, to receive the ends of the sticks of the rockets, in the rail E, and so on to the fourth rail, so that the sticks of the rockets at top, will go through all the rails; the rockets being so prepared, fix a gerbe or white flower-pot on each rail before the post, with their mouths inclining a little forwards; these gerbes must be lighted all at once; behind

behind or before each gerbe, fix a case of brilliant or slow fire, these cases must be filled so that they may burn out one after the other, to regulate the fountain, which may be done by carrying a leader, from the end of each slow or brilliant fire, into the groove in the back of each rail; different size rockets may be used in these fountains, but it will be best to fill the heads of the rockets on each rail with different sorts of things, in this manner, those at top with crackers, the next with rains, the third with serpents, the fourth with tailed stars, and the last flight with common or brilliant stars.

Palm - Tree.

This piece, though made of common fires, and of a simple construction, has a very pleasing effect; owing to the fires intersecting so often, that they resemble the branches of trees. Fig. 2d. let A, be a perpendicular post of any thickness so that it be sufficiently strong to hold the cases; let the distance from B to C, be two feet six inches, and from C to D, two feet six inches, and let the length of each cross piece be two feet; on each end of each, fix a five pointed star, then fix on pegs made on purpose, twelve inch half pound cases of brilliant fire, as in the figure, all the cases and stars, must be fired at one time; this piece should be fixed high from the ground.

Illuminated Pyramid, with Archimedian Screws, a Globe and Vertical Sun.

May be made of any size; one made according to the Dimensions of fig. 3d, will be a good proportion, whose whole height is twenty one feet; from C to D, six feet, from E to F, nine feet, the space between the rails must be six inches, and the rails as thin as possible, in all the rails stick port-fires at four inches distance; the archimedian screws G, K, are nothing more than double

double spiral wheels, with the cases placed on their wheels horizontally instead of obliquely; the vertical sun I, need not consist of more than twelve rays, to form a single glory; the globe at top must be made in proportion to the pyramid, which being prepared according to the preceding directions, place your leaders so that all the illuminating port-fires, screws, globe, and sun, may take fire together; the pyramid must be supported by the two sides, and by a support brought from a pole, which must be placed two feet from the back of the pyramid, in order that the wheels may run free.

Rose-Piece and Sun.

A rose piece may be used for a mutation of a regulated piece, or fired by itself, this piece makes the best appearance when made large; if its exterior diameter be six feet it will be a good size; fig. 4, shews the manner it appears before it is fired; let the exterior fell be made of wood, and supported by four wooden spokes, all the other parts on which the illuminations are fixed, must be made of strong iron wire; on the exterior fell, place as many half pound cases of brilliant charge as you think proper (but the more the better) for the nearer the cases are placed, the stronger will be the rays of the Sun; the illuminations should be placed within three inches of each other, they must be all fired together and burn some time before the sun is lighted, which may be done by carrying a leader from the middle of one of the illuminations, to the mouth of one of the sun cases.

Transparent Stars with Illuminated Rays.

Plate 7, Fig. 5th, represents an illuminated star, let the diameter from A to B, be two feet and from C to D, seven feet; first make a strong circular back or body of the star, two feet diameter, to which you fix the illuminated rays;

rays; in the center of the front of the body fix a spindle, on which put a double triangular wheel, six inches diameter, clothed with two ounce cases of brilliant charge; the cases on this wheel must burn but one at a time; round the edge of the body nail a hoop made of thin wood or tin, this hoop must project in front six or seven inches; in this hoop cut three or four holes to let out the smoke from the wheel; the star and garter may be cut out of strong paste-board or tin, made in this manner, cut a round piece of paste-board or tin, two feet diameter, on which draw a star, and cut it out, then over the vacancy paste Persian silk; paint the letters yellow; four of the rays yellow, and four red; the cross in the middle may be painted half red, and half yellow, or yellow and blue; this transparent star must be fastened to the wooden hoop by a screw, to take off and on, the illuminated rays are made of thin wood, with tin sockets fixed on their sides within four inches of each other; in these sockets stick illuminating port-fires; behind the point of each ray, fix a half pound case of grey, black, or chinese fire.

N. B. The illuminated rays to be lighted at the same time as the triangular wheel, or after it is burnt out, which may be done by a tin barrel being fixed to the wheel after the manner of those in the regulated pieces, into this barrel correl a leader from the illuminated rays, through the back of the star, which leader must be met by another brought from the tail of the last case on the wheel.

Transparent Table Star Illuminated.

Fig. 6th, represents a table star, whose diameter from E. to F, is twelve feet, and from E to I, four feet, this proportion observed on each side, will make the center frame four feet square, in this square fix a transparent star, as shewn in the figure; this star may be painted blue, and its rays made as those of the flaming stars described

described in page 218, the wheel for this star may be composed of different coloured fires, with a change or two of slow fire; the wheels a, a, a, a, may be clothed with any number of cases, so that the star wheel consists of the same; the illuminating port-fires, which must be placed very near each other on the frames, must be so managed as to burn as long as the wheels, and lighted at the time.

The Regulated Illuminated Spirili Piece, with a projected Star Wheel Illuminated.

This piece is represented by Fig. 7th, and is thus made; have a block made eight inches diameter, in this block screw six iron spokes, which must serve for spindles for the spiral wheels, these wheels are made as usual, each one foot six inches diameter and three foot in height; the spindles must be long enough to keep the wheels four or five inches from one another; at the end of each spindle must be a screw nut, on which the wheels that hang downwards will run, and on the spindles which stand upwards must be a shoulder, for the blocks of the wheels to run on.

The projected star wheel, must turn on the same spindle on which the large block is fixed, this spindle must be long enough to allow the star wheel to project a little before the spiral wheels; the exterior diameter of the star wheel, must be three feet five inches, on this wheel fix three circles of iron wire, and on them port-fires; on the block place a transparent star, or a large five pointed brilliant star, the cases on this wheel may burn four at once, as it will contain near twice the number of one of the spiral wheels; the cases on the spiral wheels, must be placed parallel to their fells, and burn two at a time.

A New Figure Piece Illuminated with Five Pointed Stars.

The construction of this piece is very easy, as shewn by figure 8, whose diameter from B to C, is eight feet, and from D to E, two feet, the vertical wheel in the center, must be one foot diameter, and consist of six four ounce cases of different coloured charge, which cases must burn double; on the frames of this piece, fix five pointed brilliant or blue stars, rammed four inches with composition, let the space between each star be eight inches; at each point of this piece, fix a gerbe or case of chinese fire; when this piece is to be fired let the gerbes, stars, and wheel be lighted at the same time.

The Star Wheel Illuminated.

This beautiful new invented piece, is shewn in Plate 8, fig. 9, its exterior fell is made of wood, three feet six inches or four feet diameter, within this fell, form with iron wire, three circles, one less than the other, so that the diameter of the least may be about ten inches; place the port-fires on these fells, with their mouths inclining outwards, and the port-fires on the points of the star, with their mouths projecting in front; let the exterior fell be clothed with four ounce cases of grey charge, these cases must burn four at a time, and be lighted at the same time as the illuminations.

Pyramid of Flower-pots.

Fig. 10, represents this curious piece, which must be made thus; let the distance from A to B, be six feet, and from one rail to the other two; on the bottom rail, fix five paper mortars, each three inches and a half diameter, these mortars load with serpents, crackers, stars, &c.

In

In the center of each mortar fix a case of spur fire; on the second rail fix four mortars, so as to stand exactly in the middle of the intervals of them on the bottom rail; on the third rail place three mortars; on the fourth two; and on the top of the posts one; the bottom rail must be six feet in length; all the mortars must incline a little forwards, that they may easily discharge themselves, and the spur-fires rammed exactly alike that the mortars may all be fired at the same time, having prepared your pyramid according to the preceeding directions, carry pipes of communication, from one spur-fire to the other.

The Illuminated Regulating Piece.

Fig. 11, represents one half of this piece; A, A, A, A, are flat wooden spokes, each five feet in length, and at the end of each, place a vertical wheel, ten inches diameter, clothed with six four ounce cases of brilliant fire, these cases must burn but one at a time; on two of the spokes of each wheel, place two port-fires, which must be lighted with the first case of the wheel; on each spoke A, A, &c. behind the wheels place six cases of the same size as them on the wheels; these cases must be tied across the spokes with their mouths all one way, and be made to take fire successively one after the other, so that they may assist the whole pieces to turn round.

The diameter of the wheel B, must be two feet six inches, and its fell made of wood, which must be fixed to the large spokes, on this wheel place twenty four cases of the same sort as them on the small wheels, these cases must burn four at a time; in this wheel make three circles with iron wire, and on them place illuminating port-fires, as shewn in the figure; the star points on the large spokes may be made of thin ash hoops, the diameter of these points close to the center wheel must be eleven inches; on these points place port-fires, at three inches and a half distance, one from the other.

Fig. 12, represents the blocks of this piece, the diameters of these blocks at A and B, must be eight inches and

and C and D, four inches and a half, the length of each, of these blocks must be six inches; at the small ends of these blocks fix an iron wheel five inches diameter, which wheels must have teeth, to turn the wheel E, this wheel which is fixed on a small spindle screwed into the large spindle which goes through the two blocks, and on which they run.

Supposing fig. 11, to be on the block A, in fig. 12, and to turn to the right, and another piece of the same construction on the block B, with its fires placed so as to turn it to the left, you will find them move very true and fast, by the help of the three iron wheels, which serves to regulate their motions, as well as to assist them in turning; let the iron circles in the front of the great wheels be of different diameters so that when fired there may appear six circles, when this piece is fired, all the wheels and illuminations must be lighted at one time.

To Fix a Sky-Rocket with its Stick, on the top of another.

Rockets thus managed make a pretty appearance, by reason of a fresh tail being seen when the second rocket takes fire, which will mount to a great height; the method of preparing these rockets is thus, having filled a two pounder, which must be filled only half a diameter above the piercer, and in its head not more than ten or twelve stars; the stick of this rocket must be made a little thicker than common, and when made, cut it in half the flat way, and in each half make a groove, so that when the two halves are joined, the hollow made by the grooves may be large enough to hold the stick of a half pound rocket, which rocket make and head as usual, the stick of this rocket put into the hollow of the large one, so far that the mouth of the rocket may rest on the head of the two pounder; from whose head carry a leader into the mouth of the small rocket, which being done, your rockets will be ready for firing.

A New Method of placing Leaders.

The placing leaders, on small cases or illuminations, is a much quicker, stronger, and more expeditious way than that of using pins, which method has been practised till very lately. Your port-fires being filled within about three eighths of an inch of the top, bore with an awl a hole through each side of the case close to the composition, then fill the mouths of the cases with meal powder wetted with spirit of wine, when you have thus prepared your cases, fix them on your works, then take an empty leader, and lay it on the mouths of as many cases as it will reach, then with your finger nail, mark the leader exactly in the middle of the mouth of each case, then at each mark with a pair of Scissars, cut a bit out of the pipe, so that when you put in the quick-match, it may be seen; this being done, lay the leader on the cases again with that side on which the match is seen downwards; then take some small twine, and put it through the holes in the mouths of the cases, and tie on the leader; do this to every case and then cover them with single pasted paper; by making use of the above method your works may be made very clean, there being no occasion to put dry meal powder in the mouths of the cases which always soils the works and prevents the paste from sticking.

In this treatise, I have taught the method of rolling, pinching, and filling all sorts of cases, the manner of pulverizing, mixing, and preparing, all compositions used in artificial fire-works; also the method of placing leaders, clothing wheels, fixed pieces, &c. in so plain a manner, that all fire-works may be made without any further instructions. A variety of pyrotechnical representations only depends on the genius of the maker, by fixing different cases and fires on works of various forms, of which there are many more.

But as those I have given are the principal, I shall conclude, till I have an opportunity of extending this work, which will depend on the approbation it meets with.

F I N I S.

